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When Teachers Get It Right: Voices of Black Girls' Informal STEM Learning Experiences

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When Teachers Get It Right: The Black Girls' Perspective of their STEM Learning Experiences

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> At I AM STEM, the teacher always engaged you while you were learning, and it was fun! They engaged you and they encouraged you to try to get the right answer. If you got it right, there would be a prize and so we wanted to get the correct answers. (Ana, 7th Grade)

Teacher quality is being recognized as one of the most powerful levers in improving education (Barton, 2007; Berry, 2013). With increasing student enrollments and high teacher turnover rates, many school districts are struggling to retain effective teachers, and have had to lower their hiring and recruitment standards in order to fill positions (Darling-Hammond, 2013). This practice has resulted in unqualified and underqualified mathematics and science teachers in schools across the nation (Ingersoll, 2003, 2006, 2007). Unfortunately, children who attend high-poverty and ethnically diverse schools are disproportionately affected by the harsh reality of their classes being staffed by inexperienced teachers (Darling-Hammond, 2013). This is because teachers who are more prepared to teach science and mathematics are more likely to be placed with advanced or high-achieving students rather than struggling learners (Horizon Research, 2013).

According to a recent report released by Horizon Research (2013), only 41% of middle grades science teachers hold a degree in science, science education, or engineering. The national shortage of qualified mathematics and science teachers has intensified recruitment efforts for mathematicians and scientists to become educators who can enhance teacher preparation and engage more students in STEM fields (Ingersoll, 2003, 2006, 2007). The need for quality science learning experiences for all populations of students is being realized from The White House to local communities. Former US President Barack Obama (2009), in his speech during the National Academy of Sciences annual meeting, declared that, "science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before". Science and technology innovation is the key to meeting many of the global challenges. Increasing mathematics and science education in the US, as well as the pool of students who are prepared to pursue the sciences as a career trajectory, is of utmost urgency in this global and competitive market (Hill, Corbett, & St Rose, 2010; National Academy of Science [NAS], 2007; National Center for Education Statistics [NCES], 2012).

Of particular concern is how educators prepare and encourage Black girls to enter careers in STEM disciplines. Literature indicates that even though Black girls are interested in science and mathematics, they often feel unwelcomed and experience racism and sexism in their classes (Evans-Winters, 2005; Malcolm, Hall, & Brown, 1976; Rayman & Brett, 1995; Vining-Brown, 1994). Other research supports the idea that Black girls who are high-achieving are typically disadvantaged by their teachers and school counselors who underestimate their potential and who hold low expectations for their academic success (Brickhouse & Potter, 2001; Brickhouse, Lowery, & Schultz, 2000; Next Generation Science Standards [NGSS] Lead States, 2013). In a positionality study conducted by Pringle and colleagues (2012), they reported that science and mathematics teachers often

lack an awareness of the long-term impacts of their practices on Black girls' personal and vocational pursuits. "When gender and skin color are the major factors determining who will do science, a considerable amount of scientific talent is lost" (Hanson, 2008, p. 6). In order to increase retention rates and participation of Black girls and women in the STEM disciplines, the culture of science and mathematics, as well as the educational training must be changed to one that values girls, students of color, and those from low income households (Aud et al., 2010; George, Neal, Van Horne, & Malcolm, 2001; Hanson, 2008; Hernandez-Gantes & Fletcher, 2013).

One approach to making science and mathematics more accessible is through informal science learning or STEM education programs (Dorsen, Carlson, & Goodyear, 2006; Feinstein & Meshoulam, 2014; Jones, 1997). Informal science learning refers to science learning that takes place during out-of-school time. Examples include visiting a museum, taking a stroll through the park, participating in summer programs, reading books about science, raising pets at home, and even browsing the internet (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003; Rennie, 2007). Informal STEM education programs promote an interdisciplinary approach to science, technology, engineering, and mathematics. These programs have the potential to engage populations who are underrepresented in STEM professions in powerful ways (Dorsen, Carlson, & Goodyear, 2006; Honey, Pearson, & Schweingruber, 2014). Thus, informal spaces have the potential to address educational inequities and broaden the participation of underrepresented populations in STEM careers.

This research explores how Black girls, who participated in an informal STEM program, describe teachers who were effective in teaching them science and mathematics. Gloria Ladson-Billings (2009), in her book, *The Dreamkeepers: Successful Teachers of African American Children*, emphasized the importance of excellent teaching and explored common behaviors and teaching ideologies of a group of teachers who were successful in teaching Black students. She noted that it is *the way* in which teachers teach that profoundly impacts how students respond to the curriculum. The study described in this paper, reified the importance of *the way* in which teachers engage Black girls in STEM learning –from their perspectives. This study awakened the voices of Black girls to identify best practices and characteristics of teachers who were successful in their approach to teaching them science and mathematics. Specifically, I asked the following research question: In what ways do teachers encourage the STEM learning of Black girls in informal and formal contexts?

Research Context

The context of this study is a community-based informal STEM program – Innovation, Achievement, and Motivation in Science, Technology, Engineering, and Mathematics (I AM STEM). This non-residential summer program offers a comprehensive STEM curriculum for K-12 children in the southeast region of the US, with goals of improving students' interests and engagement in the areas of science, technology, engineering, and mathematics. I AM STEM seeks to prepare students to become responsible and scientifically-literate citizens, and prevent summer learning loss, which can occur if students do not exercise their academic skills during the summer months (Cooper, 2003). Since its inception, the program has served over 450 students in one community by providing supplemental academic enrichment,

mentoring, tutoring, and character development for the overall well being of participants. I AM STEM is not funded by large state or federal grants, but is financed through generous monetary and in-kind donations from local organizations, businesses, and residents. Parents also contribute to the program costs through subsidized program fees. There is no selection process, and parents are encouraged to register their children until spaces are filled. This community-based program was created by individuals in the community, who understood the unique needs of the community, and is sustained by the continued support of the community. The 2015 iteration of I AM STEM lasted 25 days during the month of July for 6 hours each day. The participants were grouped according to grade level – kindergarten and first grade; second and third grades; fourth and fifth grades; sixth though eighth grades; and ninth through twelfth grades.

I AM STEM Camp aligns with the six strands of informal science education as presented by Feder, Shouse, Lewenstein, and Bell (2009) – which states that students should (1) experience excitement and motivation to learn about their natural and physical world; (2) generate and use concepts, explanations, and models related to science (3) manipulate, question, and observe their natural and world; (4) reflect on science as a way of knowing; (5) participate in scientific activities with others; and (6) think about themselves as science learners and contributors to science. All lessons, activities, and field trips, implemented in I AM STEM, have clear learning goals for engaging students in scientific phenomena while supporting their learning. The 2015 STEM curriculum had an overarching sustainability theme where students learned about the impacts of pollution, water quality and availability, recycling and composting, green energy, climate change, and organic gardening. Students also engaged in engineering and robotics activities with the National Society of Black Engineers (NSBE) and doctoral students in Human Centered Computing (HCC). Furthermore, health professionals from a local university hospital and college of medicine hosted a Medical Career Outreach Day for students to learn about careers in the medical field. Ethnically diverse health professionals across medical specializations taught students how to apply the sciences through demonstrations and interactive sessions. Thus further emphasizing how I AM STEM, as a community-based program, thrived from partnerships with local organizations, businesses, and university faculty and students.

I AM STEM as Culturally Healthy and Embracing Culturally Relevant Pedagogy

One of the major goals of I AM STEM is to develop and maintain culturally healthy students by meeting the needs of the whole child: mind, body, and spirit (Ladson-Billings, 1989). Gloria Ladson-Billings (1989) coined the term "culturally healthy" for minority (in particular Black) students who "enjoy a high degree of mental, emotional, intellectual, and spiritual health" (p. 230). This is accomplished by providing participants with the resources, skills, knowledge, and training to be productive, responsible, and informed citizens. Teachers engage students in meaningful learning that embrace their lived experiences through a culturally relevant curriculum, supported by mentors who are sensitive and responsive to their needs. Valuing and respecting students' lived experiences is of utmost importance because I AM STEM was built on the premise that students' home and community environments influenced their learning.

Teachers, staff, and parents support the individual needs of students through a

culturally-relevant STEM curriculum where students experience academic success, maintain their cultural competence, and develop critical consciousness (Ladson-Billings, 1995). Therefore, I AM STEM offers opportunities for children to find their passions, expand their horizons, foster strong relationships, and master new skills. Certified teachers, who teach in local public schools, serve as the main classroom instructors for I AM STEM Camp. These teachers demonstrate cultural awareness by attending to the cultural experiences of learners and implementing hands-on, minds-on, and reform-based STEM learning experiences that are engaging for children. I AM STEM teachers cultivate an interdisciplinary approach to learning, and develop science lessons that infuse technology, engineering, and mathematical concepts throughout. The enacted curriculum is developed and implemented in partnership with community groups, institutions of higher education, and volunteers from businesses and STEM-related organizations.

In efforts to embrace the students' cultures, the STEM curriculum is complemented with African American history where participants engage in dialogue around current events such as the Black Lives Matter movement and historical events such as the Civil Rights Movement. Black professionals in the community, who had humble beginnings yet experienced academic and personal success, are invited as guest speakers. In addition, teachers start each day with a morning assembly where they affirm and reaffirm the participants about how brilliant they are and the importance of democratic participation. I AM STEM is used as a vehicle to reconstruct the negative messages that society has placed on children of color in order to instill positive messages about who they are and who they will become.

Data Collection and Analysis

This study is a part of a larger research study examining the STEM learning experiences of Black girls in an informal STEM program and how they translated those experiences into practice and their formal schools (King, 2016). The researcher selected a purposive sample of 4^{th} – 8^{th} grade Black girls who participated in the informal STEM program using a maximal variation strategy to represent a range of cases across experiences (Flick, 2009; Patton, 2002). The six criteria were (a) grade level, (b) type of school the participants attended, (c) number of years involved in FOCUS, (d) household structure, (e) SES (as measured by free or reduced lunch status), and (f) whether the participant received a sponsorship of any kind to attend camp. The names presented in Table 1 are all pseudonyms to protect the participants' identities.

Table 1. Description of Research Participants

	Grade	Type of School	# Years in FOCUS	Single/Both Parents	Free/ Reduced Lunch	FOCUS Sponsorship
Stephanie	4	Private	1	Single	No	Yes
Heaven	4	Public (choice)	3	Single	Yes	Yes
Amaria	5	Public (zoned)	1	Married	Yes	Yes
Jasmine	6	Public (zoned)	2	Married	No	No
Allison	6	Public (zoned)	2	Single	Yes	Yes
Ana	7	Research School	3	Married	No	No

Three retrospective individual interviews were conducted with each participant over a six-month period immediately following the camp. Students were encouraged to share their experiences with teachers in I AM STEM, as well as their current experiences with their science and mathematics teachers.

A semi-structured interview protocol was employed for this study, and peers steeped in interviewing techniques reviewed the interview questions and question order to ensure they were appropriate to sufficiently answer this study's research question (Flick, 2009; Glesne, 2006).

Using narrative inquiry, participants generated detailed accounts of their STEM learning experiences and characteristics of teachers who encouraged their participation and engagement. This study embraced Riessman's (2008) approach to constructing narratives for inquiry, where the researcher played a major role in constituting the narrative data based on her presence, and the listening and questioning techniques she employed. Therefore, the researcher was an active participant in the construction of the narratives, as meaning was created in the interactions between the researcher and participants. After each interview, the researcher selected passages of interest to create each girl's counterstory. Passages of interest were defined as statements or stories that assisted the researcher in answering the research question (Seidman, 2013). Member checking took place throughout the study to ensure that the participants were presented in the most accurate light. Riessman (1993) purports that "interpretation is inevitable because narratives are representations" (p. 2) and that human agency and imagination determine what is included, excluded, and how events are plotted. Therefore, excerpts that are presented from the girls' counterstories in this study are partial and temporal representations of their experiences.

Riessman's (2005, 2008) typologies of interactional analysis and thematic analysis were employed for data analysis. Interactional analysis views storytelling as a co-constructive process where the researcher and teller collaborate to create meaning (Riessman, 2005). This form of analysis occurred during the retrospective individual interviews as the participant made sense of her experiences through her interactions and conversations with the researcher. After the counterstories were constructed, thematic analysis was used to explore emerging themes and theorize across counterstories to find common thematic elements (Riessman, 2005, 2008).

Results and Discussion

As the Black girls reflected on their STEM learning experiences, they identified attributes and effective practices of teachers who encouraged their learning. The three major attributes of teachers who promoted their academic success and engagement in STEM learning were ones who (a) responded to their needs and built a community of learners, (b) interacted with their parents in a professional manner, and (c) encouraged them to think critically and creatively during the lessons. The girls spoke highly of teachers in I AM STEM, as well as select teachers in their formal schools, who were creative in how they taught their lessons and challenged students to reach their full potential.

Teachers Who Responded to the Girls' Needs and Built a Community of Learners Promoted Academic Success and Engagement in STEM Learning

In describing their STEM learning experiences in I AM STEM, the girls valued having certified teachers with strong content knowledge in science and mathematics. More importantly, they appreciated how the teachers were welcoming and exuded patience by deconstructing the science and mathematical concepts in ways that were both relevant and easy to understand. Not only did teachers encourage student learning and cultivate their sociopolitical awareness, but they also ensured that the girls

understood the relevance and applicability of the content to their everyday lives. The teachers sought to pique the girls' interests and nurture their curiosities. The classroom culture was one of mutual respect where students were not afraid to take risks, be incorrect, or ask questions.

> For I AM STEM science, we have like a professional teacher from Warriors Middle School, Ms. Mays, and teachers from other schools who teach us. Ms. Mays was very nice and she kind of helped us understand different things. I would say that she was a very nice person to me and other kids, and she was very helpful and funny. I felt that she was like very smart and creative with her work. I felt comfortable talking to her and asking her questions. (Jasmine, 6th Grade)

The participants developed a strong bond with their teachers and looked up to them as mentors and role models. Jasmine described Ms. Mays as a "professional teacher" who was smart and creative, but also approachable and willing to answer her questions. Ana attends the school where Ms. Mays teaches, and reflected on the academic success that she experienced in Ms. Mays' sixth grade science class because of the content that Ms. Mays taught her during I AM STEM.

> For instance, in science, I had Ms. Mays here at I AM STEM. The next school year (2014-2015), I went to Warriors Middle School, and Ms. Mays was actually my teacher. We went over the same things and it really helped me because I AM STEM brought her to me during the summer. When I took her classes that year, I aced everything because I already knew it. So when I went in there, I was already ahead of the other students, because of the things that she had taught us in I AM STEM. (Ana, 7th Grade)

Ana exuded a sense of confidence in her experiences with Ms. Mays as her sixth grade teacher in both the informal and formal settings. Ana juxtaposed those experiences with her current formal science experiences where the teacher does not take the time to explain why things are incorrect, answer her questions, or truly engage her in science. Furthermore, Ana does not relate to the lessons and is dissatisfied with the lack of inclusion and community.

> I feel like I am better at science here at I AM STEM than at Warriors Middle School, because I get more examples and I get an explanation for the answers that I get wrong. At Warriors Middle, I don't get an explanation if I get a wrong, it's just wrong and I don't get an explanation. I feel like the activities here at I AM STEM are more exciting than the activities at Warriors Middle because for example, everybody gets a chance to do something with Ms. Mays at I AM STEM. At Warriors Middle, only certain people can do certain things 'cause my science teacher only trusts certain people. It's not a fun topic and she does not engage you to be interested in science. School can be fun, but it can be boring sometimes because when you go to certain classes, the topics that they are teaching are not related to what you want to learn about. (Ana, 7th Grade)

In Ana's final reflections, she referred back to the quality of the teachers in I AM STEM, but more importantly how the teachers cared for and welcomed the students. She even discussed how the teachers gave tests during the summer to

assess students' knowledge, and provided advice on how they could improve in order to experience academic success in their formal schools. The teachers also encouraged students to achieve their educational and career goals while pursuing their passions. The classroom felt like a family or community of learners where teachers engaged students. Building the classroom community was a collective effort centralizing students' needs and interests.

> If I AM STEM is happening again, I would like to come back because I like the environment. I love how the teachers are welcoming and the students are engaging, and I like how we go on field trips, and we try to build a big family. I am also going to tell my friends about it. Next year, I want the middle school and high school to combine classes and have the same teachers from last year. I love Ms. Little. We took tests at the beginning of the camp to see where we were at in our reading skills. After we took the test, she told us the tweaks that we needed to make to be better in school the following year. All of the teachers that were there helped me figure out that in order to get what you're dreaming about in life, you have to have high success, you have to get the education, and get the grades in order to do what you want to do in life. (Ana, 7th Grade)

The girls described the quality of the teacher-student relationships in I AM STEM that created a sense of belongingness in the classroom. According to Trask-Tate and Cunningham (2010), teacher support and academic achievement can foster a strong sense of community and maximize student learning, motivation and engagement. Jasmine and Ana shared how Ms. Mays took the time to make sure that everyone understood the lessons and that no child was left out or left behind. Her actions are consistent with NRC's (2012) recommendations for educators to provide children with equitable opportunities to strengthen their mathematical and science skills, and the necessary training to compete in the global market and become productive citizens. Ms. Mays' practice of responding to the girls' needs, answering their questions, and interacting with them in professional ways stimulated their growth and expressed interest in science. Booker (2006) talked about the importance of teachers building a community and fostering positive learning environments in maximizing student learning, motivation, and engagement. Informal learning spaces provide non-threatening and low-stakes environments for teachers to build community, develop meaningful relationships and create a positive learning spaces for students (Dierking et al., 2003; Rennie, 2007).

Teachers Who Interacted with the Girls' Parents in a Professional Manner Promoted Academic Success and Engagement in STEM Learning

In the I AM STEM 4th-5th grade class, Mrs. Dodd exuded similar qualities as Ms. Mays in the active engagement of students in their learning. Some of the girls reflected on Mrs. Dodd's ability to extend the classroom learning community to include students' parents and families. For example, Heaven, a 4th grader, recognized Mrs. Dodd's willingness to help students experience academic success by establishing strong relationships with the parents, and keeping them informed of their child's progress. Heaven perceived this approach to be effective because the STEM content that was taught in class could then be reinforced at home, with parents having access to resources and a sense of belonging in the

classroom community. Teachers, students, and parents worked together to ensure each child's academic success.

> I AM STEM teachers send papers home so that parents know how we are in camp and if we need any extra help in school, 'cause Mrs. Dodd told parents if we needed a little bit of extra help. If I ever did need extra help, my mom would print out papers, like reading and math and science. Because I didn't really know science very well, so she printed out papers for me to do because Mrs. Dodd told her that I needed help in science. (Heaven, 4th Grade)

Heaven shared her perspectives of how Mrs. Dodd was a highly effective teacher because of her open communication with parents. Heaven's mother became an integral part of her STEM learning by reinforcing science and mathematics concepts at home. Conversely, Allison, a 6th grader, reflected on a time when her mother came to the mandatory summer program in her formal school and was not treated courteously. This experience contrasts what the girls described as best practices of effective teachers.

> When I went to summer school, my teacher's name was Ms. Bailey. She was the meanest teacher! One day, my mom came to the summer school to see how I was doing and sat beside me. Ms. Bailey told my mom not to help me with my work, and my mom told her that she was only looking and wasn't helping me. I ended up getting called out of the classroom for fluency, and so my mom left the classroom. I AM STEM was very different because there were nice people and nice teachers, and a good environment. It helped me learn more things than what I learned in summer school. (Allison, 6th Grade)

Allison's mother came to her school and felt unwelcomed, and was even instructed not to assist Allison. The teacher discouraged Allison's mother from visiting the class and participating in her child's education. Allison's story is an example of a missed opportunity to bridge the gap between home and school, and parents and teachers.

Many studies have explored the influence of parental involvement on student achievement (Bogenschneider, 1997; Epstein, 1991; Jeynes, 2007), and the general consensus is that parental involvement is directly related to students' academic achievement (Fan & Chen, 2001; Jacobs & Harvey, 2005). Trask-Tate and Cunningham (2010) found that high parental involvement and high SES positively influence the academic achievement of Black girls, and that parental involvement is an important ingredient for Black girls' success in school and development of their academic aspirations. Hickman, Green, and Miller (1995) suggest that home-based parental involvement including direct assistance with schoolwork, selecting courses, and making career plans, supports students' educational achievement. Mrs. Dodd essentially fostered home-based instruction where she supported parents in the shared responsibility of their children's progress by providing supplemental materials and resources to reinforce concepts at home. This deliberate and regular communication reified parents' shared ownership in their children's education and belongingness in the classroom.

Teachers Who Encouraged the Girls to Think Critically and Creatively Promoted Academic Success and Engagement in STEM Learning

The girls reflected on the ways in which teachers engaged them in science and mathematics. They valued projects that had real-life applications and embraced opportunities to express their understanding in non-traditional and creative ways. The girls appreciated high-quality instruction and teachers who challenged them to think critically.

> So, I had a teacher and she would give us Star Math so that it would be hard. Star Math is very hard. So then she was like, "It's so hard that it will make your brain explode". I just did it at home, and I was about to yell because it was so hard. I like that they challenge me in math and reading and science and things like that. (Heaven, 4th Grade)

The girls engaged in rigorous activities during I AM STEM Camp that afforded them with opportunities to be challenged and think deeply about scientific and mathematical concepts. An example is when students designed experiments using control, dependent and independent variables, conducted their investigations to determine which factors affected plant growth, analyzed their results, redesigned their experiments, and presented their findings to their peers. This was one of many activities that provided Black girls with a space to think critically, make observations, and engage in the scientific practices.

> My favorite project was when we were growing plants in water bottles and watching it grow for a couple of days. Some people's plants didn't grow, but a couple of people's did. Mine was in the shade, and mine grew. My experiment was to see if plants could grow in a shaded area or if they could in sunlight. I had one plant in the shade and one in the sun. The one in the sun didn't grow, but the one in the shade grew. I don't know why it happened and it surprised me because I thought that the one in the sun would grow more. (Jasmine, 6th Grade)

Furthermore, the teachers scaffolded the girls' learning and provided fertile ground to promote academic growth, transfer their content-knowledge, and practice process skills in context. For example, Stephanie, a 4th grader, reflected on her experience of visiting the recycling center during I AM STEM Camp, and described the meanings of various safety symbols and the types of materials that could be recycled. As students engaged in sustainability lessons, teachers allowed them to learn the science content in context.

> We also went to the garbage place. I learned that when people come to take our recyclings, we should remember to put the right stuff in the right places, like the trash in the trash can, the recycling stuff in the recycling bins. We can recycle things like plastic and paper. We also rode down to where they make oil and soap and paints. I learned that soap can be made out of certain stuff but I don't remember the exact things. We also learned about different signs. There's certain ones where, if it has a picture of poison on it, you should stay away from it 'cause you could get hurt…or you need to tell an adult. (Stephanie, 4th Grade)

The girls noted how their teachers in the informal STEM program taught them learning strategies and skills that could be readily applied in their formal schools. For example, Heaven, a 4th grader, shared how Mrs. Dodd taught her effective methods in approaching math word problems, and

Jasmine, a 6th grader, discussed how Mr. Wright showed her how to convert decimals to percentages. The girls successfully implemented the knowledge and skills that they developed during I AM STEM into their classes at school.

> At I AM STEM, the teachers gave us things that were complicated 'cause Mrs. Dodd would tell us stuff like, "Compare stories together, compare math together." When doing the math word problems, I asked myself "what does this equal, and how does it compare to what that one equals?" (Heaven, 4th Grade)
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> Mr. Wright, the high school teacher in I AM STEM, showed us how to do decimals and how you have to move to the right to get percentages. We are doing that in math class at school. We have also been doing things with independent variables, dependent variables, and controls in science. This is like what I did in I AM STEM when I put one of the plants in the shade and the other in the sunlight to see how they grew. (Jasmine, 6th Grade)

Ana talked about how the teachers used positive reinforcement to encourage learning through the use of incentives and interactive games. This promoted both collaboration and competition in the classroom so that students were motivated to learn. They worked together to solve problems and were rewarded when they mastered new concepts, thus building collegiality, community, and confidence.

> I loved how Ms. Little, the middle school teacher, and Mr. Wright, the high school teacher with the little afro, would go to different boards, and they would come up with two different answers, and you have to see which answer was the correct one. So basically, it was a challenge. So when you have equations, they tell you how to solve for "x" and find the missing values in order to get the correct answer. At I AM STEM, the teacher always engaged you while you were learning, and it was fun! They engaged you and they encouraged you to try to get the right answer. If you got it right, there would be a prize and so we wanted to get the correct answers. (Ana, 7th Grade)

Extrinsic rewards have successfully been implemented in classrooms for decades, and are particularly effective when the rewards are aligned with students' intrinsic motivations (Slavin & Davis, 1997). The teachers in I AM STEM provided incentives to supplement classroom activities, generate interest, and help students rise to the challenge in developing their scientific and mathematical skills (Rassuli, 2012). Rubenstein and Wilson (2011) recommend that teachers include creative challenges in the classroom to encourage creative thinking, improve communication skills, and provide opportunities for students to master the content. Current science education reform efforts focus on students developing higher order thinking skills and approaching the discipline of science comprehensively (Hugerat & Kortam, 2014; NGSS Lead States, 2013). Additionally, for students to learn science in a manner consistent with the practices of scientists, they have to collaborate with their peers, be active participants, and think critically (Feder et al., 2009; Martin et al., 2012).

Conclusion and Implications

Black girls in the middle grades described effective practices of teachers who

promoted their academic success and engagement in STEM learning. They articulated that teachers who were responsive to their unique needs and built a community of learners in the classroom, were effective in creating a safe and supportive learning environment. The girls also valued when teachers established a good relationship with their parents and interacted with their families in positive and inviting manners. Furthermore, Black girls in this study, appreciated teachers who challenged them to think critically and exercise creativity during STEM lessons and activities. Teachers with these attributes were instrumental in providing positive experiences for Black girls to learn and engage in STEM activities.

Gloria Ladson-Billings (2009) explored success models to uncover attributes that made select teachers so effective in teaching Black students. She found out that the teachers in her study embraced students as learners and built communities of learners in their classrooms. Furthermore, the eight teachers positioned themselves as learners where their own knowledge was flexible and contestable. They expected their students to be producers of knowledge by encouraging student learning, developing students' cultural competence, and cultivating students' sociopolitical awareness. Similar to Ladson-Billings' findings, the girls in this study identified teachers who motivated their learning and cultivated their sociopolitical awareness, but also highlighted teachers who ensured that the content in every lesson was relevant and applicable to their everyday lives.

Teachers who exemplified these attributes served as their "dreamkeepers" and promoted the girls' engagement in STEM learning. Ibara (2006) noted how teachers should seek to develop students who are lifelong learners through continued engagement with their natural and physical world. Encouraging students to take advanced science and mathematics courses is not enough to motivate them to pursue careers in STEM; more attention needs to be placed on *how* students are experiencing these courses. Teachers' abilities to leverage students' interests, strengths, and needs in the classroom can support their participation. The teachers who were most effective in teaching the Black girls in this study were ones who were intentional about providing rich and meaningful learning experiences complemented with a safe and supportive learning environment. This reifies the importance of culturally competent teachers who can enact culturally relevant curricula for students to experience academic success, maintain their cultural competence, and develop critical consciousness (Ladson-Billings, 1995). Culturally competent teachers are aware of the biases that they bring to the classroom, and understand the unique needs of each student within the context of their community. These attributes allow teachers to make stronger connections to the lives of their students, and provide an environment that is both affirming and validating.

Although studies have investigated informal STEM programs and other intervention programs for students of color, seldom are the students' voices heard and used to inform research and practice. Only a small fraction of studies regarding schooling in the US involve students' perspectives (Seidman, 2013). Muhammad (2012) states the importance of creating spaces for Black girls to share their stories so that their voices are heard. Furthermore, Nyachae (2016) revealed how Black girls often conform to silence as a way of navigating and thriving in academic spaces of which they have often been pushed out. Black girls are interested in science, but many are often denied access due to layers of oppression within educational contexts. This study provided an

opportunity for Black girls to reflect and formulate an understanding about how teachers have effectively engaged them in STEM learning. The process of the girls sharing their stories allowed them to transition from knowledge consumer, to knowledge producer about the STEM learning experiences of Black girls. Understanding their unique experiences has the potential to inform teachers in both the informal and formal contexts on how to mitigate obstacles and promote the academic excellence of Black girls. Their stories can also inspire new teaching innovations in research and practice as critical to student success.

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