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Exploring How A Hip-Hop Based Science Program Afforded Black/Brown Girls The Space To Resist Against Black/Brown Negative Stereotypes In STEM

Gifty A. Asamani
Teachers College, Columbia University

Edmund S. Adjapong
Seton Hall University

Christopher Emdin
University of Southern California

Abstract

This longitudinal critical ethnographic study gave voices to Black and Brown girls who are racially and traditionally marginalized in STEM education. With the understanding that current science curricula are not culturally inclusive (Adjapong & Emdin, 2015; Atwater, 1996; Emdin, 2016; Ladson-Billings, 1995; Mensah, 2012; Takaki, 2012), the researchers explored the girls' responses to a science program that focused on addressing some of the existing cultural divides between urban youth of color and their counterparts, namely the Science Genius program. The goal of the study was to find out if the confidence and the engagement level of Black and Brown girls changed, and to what extent negative societal stereotypes about Black and Brown girls in science could be addressed if science were culturally relevant to their daily lives. We argue that the results of the study will provide insight into how to increase the diverse pool of participants into STEM career fields.

Keywords: science education, Black and Brown girls, urban education, science genius program, hip-hop

Introduction

There are several research reports that document the challenges of women in science education and STEM-related careers (Ceci & Williams, 2007; Hill et al., 2010; Pollack, 2013; Rosa & Mensah, 2016; Rosenbloom et al., 2008; Rossi, 1965). A better understanding of the realities and challenges of women in STEM has prompted a number of scholars to investigate the shortage of Black and Brown women in STEM-related fields, their limited representation in science education (including higher education), and the plight of Black and Brown students in K – 12 science education (Hanson, 2008; Hanson & Johnson, 2000; Harding, 1986; Jordan, 2006; Malcolm, 1989; Turner, 2002). The National Women's Law Center, in conjunction with the National Association for the Advancement of Colored People (NAACP) Legal Defense and Educational Fund, Inc., published a report titled *Unlocking Opportunity for African American Girls: A Call to Action for Educational Equity* (Smith-Evans et al., 2014). The report demonstrated that African American girls' performance in science education lagged behind that of their white counterparts due to negative public perception and low self-esteem. These negative stereotypes keep African American girls from being challenged in the classroom and/or offered more rigorous courses like Advanced Placement classes that will root their foundation in STEM education (Smith-Evans et al., 2014). It was further argued that negative stereotypes of African American girls led educators and administrators to more harshly discipline these students (Okonofua & Eberhardt, 2015).

For Black and Brown girls, being recognized as a "science person" by the larger society does not come naturally due to society's negative preconceived notions of who they are (Barton et al., 2008; Brotman & Moore, 2008; Carlone, 2004; Carlone & Johnson, 2007; Carnevale et al., 2013; O'Brien et al., 1999; Malcolm, 1989; Washington, 2011). Jordan (2006) interviewed several African American women scientists about their road to success in STEM. According to Jordan (2006), the Black female scientists expressed that in order for them to be successful, they had to rise above the negative societal perceptions of who and what a Black girl is and what a Black girl is capable of achieving, They countered perceptions about their promiscuity, loudness, disrespect, laziness, being unintelligible, or not beautiful. They also confessed that even though they were aware that the odds were stacked against them, they were able to build a strong inner-self with the help of their community of supporters.

Educators and especially science teachers must find the pedagogical methodologies that will keep the passion burning for future Black and Brown women scientists. Olneck (1995) argues that teaching that ignores student norms of behavior and communication provokes student resistance, while teaching that is responsive prompts student involvement. It was evident that an individual's science identity was also culturally motivated. Atwater (1996) has addressed the significance of culture as an intrinsic element of science teaching and learning. Further, studies demonstrate that girls of color are less likely to enroll in advanced science courses because they are unaware of the opportunities or experience a lack of confidence in their capabilities and possibly identities (Young et al., 2017). As a result, girls of color in K-12 education are less likely to identify with science or as scientists regardless of their competence in science (Archer et al., 2010; Sadker et al., 2009).

Leveraging youth cultures such as hip-hop to engage Black and Brown girls in science has been explored and has demonstrated positive effects on the outcomes of Black and Brown girls' science identity and their ability to deconstruct traditional educational spaces (Emdin, 2020). While scholars have demonstrated hip-hop to be an effective tool to engage girls of Color in science it is important to also recognize the challenges that exist within the culture.

Hip-hop based education (HHBE) is the use of hip-hop rap songs and lyrics as educational tools in the curricula (Banks, 2015; Emdin, 2010a, 2010b; Hill, 2009; Rose, 1994). Banks (2015) said hip-hop pedagogy "is a total reimagining of the classroom experience and speaks to the cultural intelligences of the students, which include the language, history, rituals, and mores of the 40-year-old, global, youth-oriented, social justice movement known as hip-hop" (p. 2). Emdin (2010b) proposes that hip-hop is a pedagogical mechanism "which involves a process of learning and or utilizing the complex nuances of communication in hip-hop and a valuing of student culture" (p. 62).The application of incorporating hip-hop into a curriculum provides an opportunity for culturally relevant instruction for youths of color by affirming their urban identities and enhancing deeper learning through connection with something that is relevant to them (Emdin, 2010a, 2016; Alim, 2007). Scholars like Gloria Ladson-Billings (1995), Django Paris (2012), and Samy Alim (2007) have argued for culturally relevant and sustaining pedagogies in urban public schools that are populated with minority students, especially African American students.

Misogyny within all social American spaces, in both hip-hop and science, is a serious issue that needs to be addressed. This is why it is essential to develop tools to allow both areas

to confront and address their biases against women. Hip-hop culture, despite criticisms of misogyny and objectifying women, creates an outlet for female artists to voice out against oppressive practices and negative female stereotypes through their lyrics and performances. Similarly, through Science Genius, a pathway towards forging a science identity is also afforded. Additionally, through hip-hop, female rappers have been able to promote feministic ideologies and female empowerment (Brown, 2009, 2013; Brown & Kwakye, 2012; Chang, 2007; Collins, 2004, 2006; Emdin, 2013, 2016; Jeffries, 2011; Tyson, 2002) even in the midst of biases against them. We argue that allowing women to use hip-hop as a tool to showcase their science competence allows them to repudiate biases in hip-hop.

Theoretical Framework

The study was rooted in Black Feminist Theory. Proponents of Black feminist thought argue that racism, sexism, class oppression, and gender identity are intimately bound together (Collins, 2002; Guy-Shelftall, 1995; Omolade, 1987).Black feministic thought is a philosophical agenda to raise awareness of the biases that Black and Brown females encounter on a regular basis and to empower women to push back against these negative occurrences in order to enable them to achieve their goals in life (Bryson, 2016; Collins, 2002, 2004; Joseph, 1995; Omolade, 1987). In her text, *Black feminist thought: Knowledge, consciousness, and the politics of empowerment* Collins (2002) declared, "when an individual Black woman's consciousness concerning how she understands her everyday life undergoes change, she can become empowered. Such consciousness may stimulate her to embark on a path of personal freedom to achieve her personal best" (p. x).

Black feminist thought was born out of the need for the Black woman to redefine her identity (as opposed to negative societal definition of her) and reclaim her-story that had been deliberately left out of the dominant mainstream media and literature. Collins, (2002) states, "Black women's self-definitions enabled them to refashion African-influenced conceptions of self and community. These self-definitions of Black womanhood were designed to resist the negative controlling images of Black womanhood advanced by Whites as well as the discriminatory social practices that these controlling images supported (p. 10)." Collins articulates how Black women intentionally reclaim power through self-definitions of their choice. Part of the fundamental propellant elements of Black feminist thought as a

sociocultural theory of social justice and inequalities are how the Black woman has historically been viewed as less than (a woman). Historically and from personal experience of the first author, women are classified as the weaker of the two general sexes (male and female) and are considered fragile and assumed to be taken care of by the stronger male gender (Gray, 2011; Prentice & Carranza, 2002). However in sharp contradiction, such depiction of a woman warranting caretaking by virtue of being a woman is solely reserved for the white woman (Collins, 2002; Guy-Shelftall, 1995; Lockhart, 2018; Omolade, 1987).

This study explored how participation in the science Genius program, a program that uses hip-hop to engage historically marginalized youth in science, affords urban Black and Brown girls the cultural space and confidence to push back against racism and gender biases while engaging in science. The results of the study will depict how the participants were able to not only overcome negative Black and Brown stereotypes and celebrate their Blackness but also reclaim their scientific identities.

Methods

Program Description

The mission of the Science Genius program, a hip-hop based science initiative, is to engage urban youths of Color in authentic science activities by infusing hip-hop cultural music. We argue that a hip-hop based science program creates the sociocultural space needed for urban Black and Brown girls to achieve in science while overcoming negative race/gender stereotypes.

The fact is, most urban Black and Brown youths already ascribe to hip-hop culture, so it makes sense for educators to meet them where they are (culturally) and then add the science content (Emdin, 2010a, 2010b, 2016). Furthermore, many researchers (e.g., Brown et al., 1989; Brown et al., 2005; Duncan & Rivet, 2013; Emdin, 2016; Ladson-Billings, 1995) have argued that when students see the representation of their culture in their science classrooms, this helps to boost their self-confidence while learning the nature of science (NOS) to become scientifically literate and motivates them to engage in subsequent authentic STEM activities.

Participation in the Science Genius program requires that students write their own science-based rap lyrics and perform the rap at a “science battle” (the Final Battle), whether as individuals or in a group. As the participants create their own lyrics and music, they construct

their own scientific knowledge, understanding, and identities. The content becomes more relative and meaningful to their daily lives (Adjapong & Emdin, 2015; Driver et al., 1994; Emdin, 2010a, 2010b; Krajcik & Blumenfeld, 2006). The topics that the students work on are aligned to the assessment frameworks of the New York State Science Standards, the Common Core Learning Standards, and the Next Generation Science Standards Emdin, 2010a, 2010b).

The Science Genius program also started with a focus on young urban African American and Latino males; however, young women have been participants since its inception. Similarly, hip-hop began with males, but females have successfully integrated into the music and culture.

The last phase of the Science Genius program is to have students (either as individuals or groups) representing various high schools across New York City compete at a Final Battle. The selection process begins about four weeks before the date of the Final Battle and if chosen, the student(s) have the opportunity to represent their school. After the selection process is completed, the individuals or groups representing their local schools are invited to Teachers College, Columbia University for further practice (to receive help with stage performance and to familiarize themselves with the protocol for the upcoming Science Genius Final B.A.T.T.L.E.S) with the author, the creator of the Science Genius program and an associate professor of Science Education at Teachers College, Columbia University, and their performance coaches from their local schools.

The road to the Final Battle begins at the various high schools. Students working as groups or individuals compete against each other at their local campuses, and the best group or individual is selected by the school to represent the school at the Final Battle where they will compete against other students from other schools. At the Final Battle, the students are judged based on the strength of their (a) science content lyrics: demonstration of content knowledge and understanding, (b) sociopolitical message tied to their science rap lyrics, and (c) performance aptitude: how well they conveyed both their scientific knowledge and their sociopolitical message to the public. Three individuals invited (Emdin, 2010a, 2010b) are invited to serve as judges at the Final Battle and may include scientists, rap artists, and public or community figures.

As a hip-hop based science program, the Science Genius program provides students with an innovative way to learn science and the latitude to showcase their newly constructed knowledge of science by adhering to a cultural norm that is relevant to their daily lives.

Hence, the Science Genius program is at the intersection of scientific knowledge and culture that fosters a new epistemological experience in scientific literacy. Tobin (1993) claimed that in a socially constructivist classroom, the students take ownership of their learning and construct new knowledge based on their intersectionalities and cultural identities. This program aligns to a socially constructivist science classroom.

Research Question

The research question for this study is:

To what extent does participation in a hip-hop science program afford Black and Brown girls the space to resist negative Black/Brown female stereotypes in STEM and hip-hop?

Setting

The study took place in an urban, low-income public high school. The school is located in the South Bronx area of New York City, the poorest congressional district in the United States. The school population includes roughly 400 students and is mostly Hispanics (72%) and African Americans (25%), with 1% Asian and another 1% white, according to the school's website. Additionally, 28% of the student body is labeled as English as a New Language (ENL; formerly known as English Language Learners) students, and 26% of the school population is special needs students (students with individualized education programs [IEPs]). All of the students qualified for free or reduced-price lunch.

Participants

The initial participants were 2 African American and 2 Hispanic high school girls. This number changed because one of the participants transferred to another school and could no longer participate. However, the findings will reflect her participation for the time she was part of the study. One of the authors was also their science teacher and the Science Genius program coach. While there has been some critique of teachers engaging in research with their students, the nature of the student/teacher and researcher/subject relationship in many ways enhances this study. I am upfront about our shared experiences as females of Color and perceive the work we (author and participants) engage in together less as research on subjects, but as interrogations with them. As their coach, this researcher worked closely with them and facilitated their Science Genius activities both on and off campus. The girls were enrolled in

the same Living Environment course section that met every day of the week. Consequently, it was feasible for the participants to collaborate with each other.

The participants were all born in the United States and spoke English fluently. The participants lived in the South Bronx; however, one of them was born in Queens, raised in Philadelphia, and returned to New York City (South Bronx) to reside with her aunt to complete high school. None of the participants lived with their biological fathers, and none of them had parents or siblings with a STEM degree or who worked in a STEM -related environment. The four original participants were Princes, Rebecca, Nani, and Joy.

Princess

Princess at the tender age of fifteen is the most vivacious member of the group who is like the mitochondria of the cell because she brings all the energy to the group. She is the middle child of five and the only girl. She lived with her brothers, mother and step-dad. She does not have any relationship with her biological father. Because of an ongoing tension with her mother, she moved from Philadelphia to New Work to live with her aunt who is on permanent disability. Despite her vicarious and carefree attitude, she is actually always living in a constant state of fear and uncertainty due to her aunt's illnesses that could affect her housing and accommodations. While performing well in science, she escapes through writing and plans to pursue a career in journalism. Thus, the Science Genius program offered her the perfect platform to showcase her writing abilities in association with science.

Rebecca

Rebecca is sixteen years old and lives with her younger brother, sister, mother and step-dad. Though both of her parents have an elementary-level schooling, she is focused on her education and would like to be a teacher later in life. She is soft spoken and an introvert. In addition, Rebecca struggled through science since middle school and said, "I had no one at home to help me." Her decision to participate in the Science Genius program was precipitated by her excitement to do science through music even though she continuously laments "Ms., I am not a rap person but I will try and write the lyrics."

Nani

Nani is fifteen years of age and lives with her mother and four brothers. She is the oldest. Being the oldest child and the only girl at home, she feels a bit isolated because she does not have anyone to relate to. Her mother is restrictive and supportive but she usually

works long hours. Although Nani will not describe herself as a "science person," she said "I enjoy music" and wanted to be part of something that shows academic promise for the future. She was diligent and excited about the Science Genius program and even brought her mobile speakers to help her group during their practice sessions.

Joy

Joy is sixteen years old and has an identical twin sister. They live with their mother and their younger brother. In addition, Joy's mother has accepted a friend of hers to live with them. Joy enjoys learning science but does not have a good grasp in science understanding. The idea of using hip hop music to deepen science knowledge was new to her, thus, her interest in wanting to participate in the Science Genius program. She was among the first students to sign up, and she never faltered.

Procedure/Process

The study was based on the unit of Reproduction and Development. The unit consisted of 6 lessons ranging from "What is Reproduction" to "Human Reproduction and Development." The unit consisted of 6 lessons—a quiz was administered at the end of each lesson. There was a test after the first three lessons and then another one at the end of the unit. I took four weeks to complete the unit. At the beginning of the unit I identified girls in science (among those enrolled in my science classes), and I also identified the girls that engaged in/with hip-hop music/ culture through a Likert scale questionnaire. I introduced these girls to a hip-hop based science program, Science Genius. For comparison, I identified other students and introduced them to the hip-hop science program. All my students in the class were taught the same science content.

However, as part of their in-class formative assessment, the students interested in the hip-hop based science program (including my targeted girls) created rap lyrics to demonstrate their science content knowledge and understanding. The students with science-based rap lyrics were given the opportunity to compete in the Science Genius Final Battle after an initial competition on campus at their local school. The prospect of participating in a rap-based competition served as an additional motivational factor for the students to work harder. The participants of this research won the competition at their school. I continued to observe the targeted girls over a period of 2.5 academic years both on/off campuses (during their

practices/performances outside of school) and noted any changes and/or patterns of behavior that particularly pertained to science education.

Data Collection Methods

The study started during the participants' sophomore year of high school and spanned across 2 academic years. The participants worked together to write and then perform their science rap lyrics based on content that was covered in class. Initially, they had about 6 weeks to collaborate, write their lyrics, and perfect their rap song and performance. The main data sources were obtained from their individual interviews, rap lyrics, video vignettes, reflective journal entries, Likert-scale questionnaires, and focus group interviews. Other data sources were gathered from participant observations (both in/out of the classroom) and field notes.

Interviews

Researchers conducted multiple mini interviews with participants particularly at the end each session, to gauge their progress and/or struggles. Some targeted questions students were asked were:

> Explain how you are making connections between what you are learning in class and society?
>
> Explain how that is shaping your decision to likely see yourself as a scientist?
>
> For as far back as you can remember, do you think that boys are expected to achieve better in school over girls? What about in science?
>
> Do you think that any of your science teachers encouraged the boys over the girls?

Science rap lyrics/video vignettes

In addition to collaborating in class, the participants met once a week either during lunch or after school to work on their lyrics and practice their performance. They wrote their lyrics based on content being taught in class and were encouraged to make connections from the content to societal issues confronting their everyday lives.

Reflective journal entries

Students were encouraged to frequently reflect on their experiences during the course of the study. Participants responded to weekly prompts such as: 1) How are you doing in science class? Explain what is working for you? What is/are area(s) of improvement(s)?

Likert-scale questionnaire

Likert scale survey was another tool used to increase the data collection modalities. It offered an avenue to elicit data from the students which helped the authors to implement follow up questions for both the individual and focused group interviews.

Have you had a science teacher who was sexist?

Did you believe you could exert yourself against the teacher?

Did you exert yourself? Explain (What did you do specifically?)

What is your interest in pursuing a STEM career in college or after high school?

Focus group interviews

Participants were interviewed as a group three times over the course of the study. The goal of these interviews was to capture any noted changes about their science identities, their resiliency to do and perform science, and how the students' outlook about hip-hop infusion in the science classroom. Though the students were asked several questions, the following are some questions that helped to capture the essence of this study: 1) Since participating in the Science Genius program, has there been a change in your outlook toward science? School? Social outlook due to performing in front of a crowd? 2) Explain any similarities between how women are treated in science education and how they are treated in hip-hop? 3) Do you feel more confident doing science since your participation in the program? In what way? 4) How do you feel about using hip-hop to promote science knowledge?

Data Analysis

To ensure the effectiveness of the analysis, several qualitative analytical tools were employed during this study through reflective journal entries, interviews, interviews, and field notes. All audio/video recordings during interview sessions were transcribed and coded for emerging themes that depicted students' experiential progress with the hip-hop STEM program in alignment with their sociopolitical awareness. Field notes and classroom and group session observations were also coded for recurring themes. All videotaped vignettes were analyzed to track participants' progressive science understanding from creating their science rap lyrics to their stage performances by employing qualitative coding techniques, including member checking (Creswell, 2013; Guba & Lincoln, 1989).

The rap lyrics served as a cultural artifact that was analyzed for its science content. All interview recordings were coded to show possibly repeated themes. The transcription was

initially entered into a Microsoft Word document to categorize the themes, and then the noted categories were further analyzed and organized using NVivo (Boeije, 2009; Creswell, 2013; Denzin & Lincoln, 1994). The three themes that emerged from the data analysis were: 1) Coming of age- Black and Brown feminism in STEM spaces; 2) Embracing science identity; 3) Increased affinity towards STEM and a STEM career.

Findings

Our focus on Black and Brown girls for this study was by no means an accident. Not only for the obvious reason that one of the authors is a Black female scientist who can appreciate the struggles of aspiring Black and Brown women scientists but because there are so few of us in a very vast white, male dominated field. Another motivational factor was because as educators who work with poor urban public high schools, our motivations have always revolved around what we could do to help young Black and Brown female students to sustain their interest in science from grade school through high school with the hope that they would manage to leverage a career in STEM.

The all-girl participants used the program to not only learn science but also they fought against Black and Brown female gender biases in science and hip-hop. In a focus group that occurred at the end of the study, we asked the participants to reflect on taking part in a program that was once designated to attract only boys. Rebecca said, “What else is new?” Then Joy said, “Not surprised because we [females] are usually the last to be included in anything. Facts! Sad but true.” Princess added, “It doesn't matter ‘cause we [an all-girl group] came and crushed the competition anyway, word!” The girls came in second place at the Final Battle.

Coming of Age: Black and Brown Feminism in STEM Spaces

Prior to the day of the Science Genius Final B.A.T.T.L.E.S in June of 2015, we discussed with all participants the types of outfits (pants, skirt, dress) and even the color of their outfits so that they would be in sync as a group. On the day of the event, we realized that they kept their promise about having uniform colors, but they surprised us with their outfit choices. One of the participants in particular wore a skirt and a top that were quite revealing.

Upon arrival at Teachers College, Columbia University, the venue for the Final B.A.T.T.L.E.S, about 2 hours before the event was to begin, we met with the girls. We (the

coaches, producers, and directors of the program) were more interested in helping them represent themselves tastefully for their science rap performance. Moreover, we wanted to assure them that we “saw” them, we "heard" them, and we celebrated them and their intelligence without succumbing to societal perceptions of inadequate Black and Brown girls or sexy female rap performers.

We found the dress code issue to be a very delicate one to navigate because on the one hand, we wanted them to make their own choices and not feel pressured or judged by their choices. On the other hand, we realized that they were not yet free from the conundrums of gender biases and negative societal generalizations about Black and Brown girls and female rappers. Besides at that time, the girls had not yet matured enough to understand the cultural capital to push back against a dominant force in society that continuously exerts pressure on the non-mainstream to conform. Rather, they succumbed to and embraced the very same negative stereotypes used by the oppressor to delegitimize and belittle their intelligence and status in society. Dominant society has prescribed norms of behavior that are related to what to wear, how to wear it, the way to speak, and even the language to use in order to determine one’s degree of cultural conformity and acceptance in society (Hoxie, 1984; Laxson, 1991).

It is interesting yet rewarding that the girls came to realize that they had the intelligence and ability to do science without having to hide behind a facade. That is, with subsequent performances, I observed that the participants became increasingly confident with themselves and the intellectual space afforded them to showcase their scientific knowledge. For example, at their very first Science Genius Final B.A.T.T.L.E.S performance, the girls came dressed in outfits that could be considered “too sexy.” As their teacher and coach, I wanted to make sure that they dressed appropriately for the show and properly represented themselves for the event. I didn’t want them to be misjudged. The fact is, even though it was an event to display scientific knowledge, there was a rap culture component to it, and the girls’ initial instincts were to mimic female rap artists who often dress in a very racy or risqué way.

It is worth noting that the girls in this study came of age when female rap performers like Nikki Minaj and Lil’ Kim were the iconic representation of female rappers. These artists were very popular not only for their music but because they were notorious for exposing much of their bodies in their rap videos and also during their time on and off stage. The participants, being young, were highly impressionable and likely looked up to these famous

female rappers of their generation. As such, the girls mistook the professional female rappers' revealing way of dressing as the reason why they were popular and not because they were effective lyricists. They (girls) certainly had not yet matured enough to accept that these female rappers that they idolized did not need to use their sexuality to be successful. In focus group interviews, all three of the participants agreed that female rappers do not get the same respect as their male counterparts.

Princess said, "I mean the female rappers have to work twice as hard to get a little bit of respect that the male rappers like Jay Z will get." Consequently, it was not surprising that the participants, an all-girl group involved in a hip-hop based science competition, felt that they had to objectify themselves like their idols to be accepted.

Resilience: Pushing the Boundaries: Embracing Science Identity

In light of the knowledge about the experiences that Native Americans, Black, and Brown people, and other immigrant groups (including myself) have had to endure in trying to adapt to the dominant American culture for acceptance (sort of like *code switching* as discussed by Emdin, 2016), we can sincerely sympathize with the girls' display of empowerment, although their pushback was misplaced. They didn't want anyone to tell them how to dress even though their choices subjected them to and affirmed the very negative stereotypes they were fighting against. I believed that they were still in a state of disillusion and needed time to garner confidence in their ability to free themselves from all harbored negative stereotypes and be truly empowered. It was a journey, a process in which they had not yet triumphed. So at that point, when they resisted my advice, I knew that I had to take a step back and allow them to be able to learn how to align their resistance/resilience in the manner they described in their own science rap lyrics so there was no contradiction between their message and their appearance. Unfortunately, on that day, their behavior (choice of clothing for the most part) contradicted their stand against being objectified by boys. In their science rap lyrics they said,

> boys want their sperm cells
> to slide right inside of me
> While im tryna fight my anxiety and the rage raising inside of me
> i'm not with it, i'mma dub it quick
> cause its gonna take my energy

> boys always wanna play games
> but i realized it was just a trick
> something like a counterfeit
> a indicator of a substance

With these lyrics, the girls illustrated their resistance toward unwanted male advances while taking a stand against promiscuity. They expressed maturity in understanding and accepting that most attention from boys is not genuine, so they must fight back against them. Their science rap lyrics described a group of young girls who were frustrated with societal perceptions of them, so they wanted to send a strong message of empowerment over their bodies and opposition against any gender and racial biases toward Black and Brown girls.

The judges explained that the top three groups were chosen because they had the strongest science content lyrics in conjunction with a strong sociopolitical message. After a second round of competition, the girls were awarded the second-place trophy. Though appreciative, the participants believed that they should have won first place because in their estimate they had the strongest sociopolitical message in relation to the group that won first place who were a mixed group of boys and girls but mostly boys (four girls and seven boys). To that end, Princess said,

> At our performance, we [an all-girl group] had the best science rap lyrics, but we still got second place, so I feel like it's not only about appearance and lyrics but also a lot about perception, how people perceive us [girls], and one person's opinion could affect the whole world's outlook . . . we definitely should've won, our lyrics had a very strong message. They [judges and audience] were not expecting us to come up with strong lyrics and performances. [They did] not expect us to be as dominant, aggressive and vulgar like a male artist. Females always had to do extra stuff, work twice as hard to get noticed.

At first the girls were shocked they won second place. Then they were disappointed that they did not win it all. However, despite their second place honor, I believe that this achievement was a turning point in how the girls perceived themselves as scientists and female rap artists. They felt validated not only among their peers, but they had three

reputable judges (one of which was a male scientist, another a female scientist/rapper, and the last one a celebrated male television and movie actor) recognize their work and award them for their scientific knowledge and sociopolitical stance. Their confidence levels increased tremendously, and they began to realize that yes they can, yes they did that, and yes they were celebrated for their achievements. They said to me, "Ms., we did it!" More importantly, it was at this moment that the girls came to the realization that they were good enough, their science intellect was good enough, and they did not need to physically expose themselves to be admired.

Henceforth, with each performance of their science rap song, the girls appeared more confident and free. They held onto their edgy attitudes (or ratchetness, they were *ratchedemics*, as Emdin, 2021 describes), but they made better choices in their wardrobe styles. They were liberated from the psychological paradox and struggle that previously led them to question their science aptitude because of their race, gender, and socioeconomic status. They were also free from dressing in a way that confirmed negative stereotypes about what Black and Brown girls should look like or how female rap artists should dress.

The participants now believed that Black and Brown girls from the "hood" could do science too on a "big stage." Their emotional and psychological transformations were magical. The next time they performed their science rap lyrics was at the Schomburg Center for Research in Black Culture and this time, their clothing style and performance correctly aligned with their message of science, empowerment, resistance, and Black feministic thought. They wore basic blue jeans, a baseball caps, and matching Science Genius t-shirts. Their outfits were simple but effective, with no pretentiousness.

Unfortunately, most high school students often have not yet developed the emotional strength to resist these harmful descriptions, they instead affirm these negativities by behaving badly as "they"—oppressive school systems and society—expect them to. However, the girls learned that pushing back against negative societal stereotypes does not mean perpetuating those negative behaviors.

On the Monday following their show at the Schomburg, I met with the participants after school for a focus group interview to reflect on their shared experiences at the book launch.

Researcher: How did you feel about performing your science rap in front of an audience in this space–mostly adults and highly educated people?

Princess: We were hype; we felt like celebrities, we felt very proud to show off our knowledge of science. It was still exciting almost a year after our original performance [at the Science Genius Final B.A.T.T.L.E.S]. It was great that our message still has an impact, and people responded very well to it. This program has made us feel so important, we are doing science and we got standing ovations for it. That's just real cool, dope.

Researcher: What is your takeaway message?

Rebecca: For people who didn't even think we could do science, this is so special to be able to rap about it and make sense of it. We feel like we have done something important.

Additionally, before the inception of the study, the participants struggled in their science classes even though they showed significant effort in class. However, after engagement in the program their perception of science had changed because their in class performance improved.

Increased Affinity Towards STEM and a STEM Career

At a critical threshold where the students were able to identify hip hop as a relevant cultural vehicle for them to learn science, they had an epiphany that science was doable, that they too could do science. To emphasize their breakthrough and newfound identity as capable scientists, for their stage name, the girls called themselves Reaching Capacity, and in their rap lyrics they wrote, "Nothing's impossible when you're reaching your capacity."

One of the authors (and classroom teacher) observed the girls' transition from being shy and uncertain about their capabilities in science to being unapologetically confident young Black and Brown students performing science on stage while highlighting deep social justice challenges that they were confronted with on a daily basis. Rebecca and Joy were particularly shy and introverted individuals, and Princess was an extroverted person.

However, regardless of their discrete personalities, they each distinctively struggled with science knowledge acquisition before they started the Science Genius program. Rebecca said,

> Before participating in the Science Genius program, I felt as though the most important thing about science was to have a good memory in order to remember everything. This made science very difficult for me because I could not remember many important science terms. After participating in this program, it amazed me how quickly I could remember my lines and the fact that I was rapping about science in such a different way that it helped me memorize science terms.

With the use of hip-hop as a vehicle to learn science, Rebecca was able to master a content area that was once difficult for her and was better able to understand, absorb, and recall the science content. Science became easier for her because she was able to find cultural relevancy in the hip-hop based science program. Joy, who was hardworking yet struggled the most out of the three participants, admitted in a journal entry, "I feel like I can learn science now, I think all teachers should try this [using hip-hop to learn the content]. I mean science doesn't seem so weird now." At a later date, I asked Joy to explain why she thought science was peculiar prior to her participation in the hip-hop based science program, and Joy explained why:

> Well Ms., before I use to try my hardest to understand these science ideas and words to make sense to me but it was hard. But when you told us to write bars and add beats to it, they started to make sense to me. I mean, at first it wasn't easy because the rap bars has to make sense scientifically, but I could relate to the whole thing. I felt good about rapping about science.

Princess, who was an extrovert and exuded a natural confidence about her, was equally insecure about her prospects in learning science. Notwithstanding, she often boasted in class about how much she liked science and that it was her favorite subject. She often reminisced about how she used to manage an "A" average in science in elementary school.

Unfortunately, she was barely making a "B" average preceding the inception of the hip-hop based science program.

In the case of Princess, there was clearly a missing link between her affinity toward science as a subject matter and her achievement in science in high school. I can, however, attest that, like her co-participants, Princess also put in a good amount of effort in her science class. She completed all her assigned homework and projects and readily contributed to class discussions. As such, she was one of the students I knew I wanted to include when I embarked on the implementation of the hip-hop based science program because I thought that she would benefit from learning science through a different lens.

As time progressed, I realized that Princess's (along with her counterparts) commitment to the hip-hop based science program became increasingly strong. I observed that, as she started gaining more and more understanding of the science content through the use of hip hop, her insecurities around her ability to perform in science began to dissipate. In her journal she wrote, "I feel like I can do this now. I mean, I like science and all, but my grades were not cutting it, for real."

After the first year of her involvement in the hip-hop based science program, I sat down with Princess to inquire about her perspective on science and her progression since the program began.

> The SG [Science Genius] program has helped me a lot. I thought I liked science before, but now I can actually understand what I am learning; writing the lyrics forces you to dig deeper with understanding because the bars got to make sense scientifically, you know. I now feel more confident about science.

Prior to her involvement in the hip-hop based science program, Princess would habitually tell anyone who would listen that she was a writer and was going to major in English in college. However, in a recent follow-up phone interview, she excitedly said, "Ms., I changed my mind, I am majoring in computer science." As of the writing of this dissertation, Princess, Joy, and Rebecca are first-year students in college.

Researcher: Why the change of major?

Princess: Science has become more comfortable for me to learn. Even though I always liked the idea of science, I didn't think I could actually major in science in the future.
Researcher: What changed?
Princess: I mean since the whole science with rap program and stage performances about science, I've just gotten more and more confidence with it, and now I feel like I can really follow my passion to obtain a science degree. Maybe I would be a science writer in the future.

It was rewarding that her participation in the hip-hop based science program had opened new possibilities for her to realize herself as a future scientist. When presented with the opportunity to do science through a new pedagogical format that was also culturally relevant, all three participants gained increased confidence in their abilities to both learn and share their scientific knowledge with various audiences in NYC. The girls became increasingly confident with each subsequent performance of their science rap lyrics. In a focus group interview during the second year after the study began, Rebecca said,

I have a very extreme amount of confidence after my participation in this great program. My self-esteem was shot up once I realized that I could get up on stage and perform a rap song about science of all things because science used to be hard for me.

As demonstrated in their rap lyrics below, they expressed how they had realized that "science" as an academic course was not an adversary to their progress but rather valuable content to help them to learn about who they were:

Science ain't the enemy
it lets me know what's inside of me
ya watching my complexity
learning chemistry feels like ecstasy

As of the writing of this paper, two of the participants have completed a minimum of 2 years of college. Princess has an Associate degree in computer science and is looking forward to achieving her Bachelor of Science in Computer Science. Rebecca is also two years away from completing her degree in childhood education. She said "the SG program gave me a valuable tool in seeing science in a fun way that I can do and teach my future students."

Discussion/Conclusion

In this longitudinal critical ethnographic study, we explored how a hip-hop based science program—the Science Genius program—made an indelible impact on the science education of three urban Black and Brown female students from the South Bronx. Through the implementation of the culturally relevant program, I was fortunate to spend ample time (about 2.5 years) with Princess, Rebecca, and Joy, three remarkable Black and Brown young girls who were able to frame their scientific identities, acquire scientific knowledge, and push back against negative Black/Brown stereotypes because the parameters of science education were redefined.

The rap component of the program provided the girls with necessary latitude to therapeutically voice their internal frustrations (Emdin, Adjapong, Levy, 2016; Tyson, 2002) about the sociopolitical issues that afflict them like race/gender inequalities, sexual assault, depression, and disparaging imagery of the intellectual abilities of Black and Brown girls. In her final journal entry, Rebecca, the girl who initially disliked science because she found the content to be extremely difficult to absorb wrote the following:

> I have a very extreme amount of confidence after my participation in this great program, my self-esteem was brought up once I realized that I could get up on stage and perform a rap song about science of all things because science used to be hard for me. I feel like more teachers should get more involved in this program and create more publicity to get more kids aware of it because I feel like it will help kids like me who may not like or understand science at first to really see science in a different way–like some fun and that they can do [it].

Coincidentally, before the #MeToo and #Time'sUp movements began to capture the nation's attention in October of 2017, we asked the participants in June of 2017 to express how they felt about having the hip-hop based science program's platform to talk about sexual abuse and harassment. Interestingly enough, one girl, Princess, wrote the following:

> It made me feel like I actually had a voice because a lot of people go through mad stuff, a lot of people especially girls or women are subjected to this [sexual assault] the most. We are prone to this all the time and we do not even have a choice. They [girls/women] don't feel like they have the voice to speak up. It [story about "Amber"] wasn't even personalized but it was OD [very much] generalized. A lot of girls go through sexual abuse, but they don't have the parents to talk to, and they want to kill themselves [but then they] act like they are okay, but they really dying inside, like the whole Amber part. So we helped to bring reality to the whole sexual abuse thing. I feel like our rap brought a lot of awareness. I feel like when we performed, our message was received well.

Overall, the Science Genius program was a great experience. It affirmed what Dewey (1902) said about the child "and not the subject-matter which determines both quality and quantity of learning" (p. 9) and that for the child, "things hardly come within his experience unless they touch, intimately and obviously, his own well-being, or that of his family and friends" (Dewey, 1902, p. 5).

Through the hip-hop based science program, the participants gained confidence to learn science because it had become socially and culturally relatable. The program afforded them the space to express their hidden frustrations with race/gender, self-esteem, sexual assault/ harassment, and other social challenges that may have created barriers against Black and Brown girls in the science classroom. One participant, Rebecca, said, "Ever since I participated in the SG [Science Genius] program, I've looked at science differently, mostly because I realized that science can be fun and an interesting subject as well as educational."

The results of the study have implications for ongoing professional development for both pre-service and in-service science teachers on how best to engage urban Black and Brown students with respect to science and their cultural norms. Furthermore, several researchers have argued that a child walks into the classroom with perceived notions about

the world that are ingrained in his/her culture and must be taken into consideration when designing a lesson (Dewey, 1902; Duschl, 2008; Lederman, 1999; Sandoval, 2005). Educators need to work with policymakers and curriculum designers to ensure that the curricula put forth meet the needs of *all Americans* (Lee, 1997).

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ABOUT THE AUTHORS

Gifty Asamani (she/her) is an assistant professor of Science Education at Teachers College, Columbia University. Dr. Asamani can be reached can be reached at Teachers College, Columbia University, 525 W120th St Box 75, New York, NY 10027, or via e-mail.

Edmund Adjapong (he/him) is an Assistant Professor of Educational Studies at Seton Hall University. Dr. Adjapong can be reached at Seton Hall University, 400 W S Orange, NJ 07079, via email: Edmund.adjapong@shu.edu, or Twitter: @KingAdjapong

Christopher Emdin (he/him) is a Professor of Education at the University of Southern California Rossier School of Education and chair of the Department of Curriculum and Teaching. Dr. Emdin can be reached via email: Emdin@usc.edu or Twitter: @chrisemdin