Girls Stem Institute: Transforming and Empowering Black Girls in Mathematics Through Stem

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Abstract

With the growing interest in STEM at both the national and international level, as well as the persistence in racial disparities in educational achievement, it is crucial that educators provide learning experiences that foster the positive development of Black females' mathematics and science identities. This chapter will describe Girls *STEM* Institute (*GSI*), a program designed to support the positive development of Black females as learners and doers of mathematics and science. *GSI* provides learners who identify as Black and female an opportunity to develop an understanding of mathematics and other *STEM* concepts in a meaningful and culturally grounded out-of-school context. Within *GSI's* rich, rigorous, relevant, and supportive environment, young ladies have the freedom to grow interpersonally and intellectually and are empowered to use *STEM* as a tool for personal and social change.

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I was the only African American in my honors geometry class, people would look at me like why is she here? I was like I am not going to the front. I am in AVID and we have to sit in the front but I sat in the back. The teacher asked me why I was sitting in the back and I was like I am not sitting in the front. During group work time, the teacher had to put them in a group with me, because the majority of the students did not want to pair up with me. When they recognize that I as smart as they were they started to pair up with me. ~ Paula

Imagine the feeling of embarrassment when you ask a question about a problem that everyone understands. Imagine the feeling of invisibility when the posters of scientists and mathematicians in the classroom do not look like you. Imagine being the student in the room who does not have a name, but is merely a number, a low number that failed the last math test. Imagine not getting the joke that everyone laughs at or the last person asked to join the group. Imagine not feeling adequate to learn math, do well in math, or receive valuable feedback in math. It is unfortunate to imagine these experiences; it is more unfortunate to live them. While these experiences are dehumanizing for many children across the nation, they are not uncommon, particularly for young, Black female students.

Being Black and a Young Woman

Being a young black woman it is like he [the teacher] *is intimidated by me instead of trying to teach me...I don't have an attitude. ~ Janice*

To understand the schooling experiences of Black girls, one must recognize the unique challenges Black girls face because they are Black and a young woman (Evans-Winters 2011, 28). In most K-12 schools, as a Black person, Black girls face limited access to STEM course

offerings and rigorous STEM learning experiences (Perry, et al. 2012, 4). Only 57% of Black high school students have access to the full range or core STEM courses (Algebra I, Algebra II, Geometry, Biology, and Chemistry) compared to 71% of white high school students (Smith-Evans 2014, 8-9). As a Black person and young woman, Black girls face greater barriers to STEM courses. Starting in elementary school, through teacher and counselors' referrals, Black girls are often positioned outside of mathematics and science courses (Archer-Banks and Behar-Horenstein 2012, 201). The inequitable placement and referral practices of school personnel are often linked to their perceptions of Black girls, perceptions tainted by negative stereotypes which lead to differential treatment and expectations. For example, Black girls are often stereotyped as talkative, loud, confrontational and assertive; characteristics that clash with white-middle class notions of femininity (National Women's Law Center and Girls for Gender Equity 2010, 10). Therefore, teachers assume Black girls need more social correction, and more emphasis is placed on social correction rather than academic development and achievement (Morris 2007, 501-503). Black girls are leaving high school not ready for college and careers which can lead to detrimental economic consequences for them, their families and communities (Smith-Evans 2014, 35).

Learning Mathematics in a Traditional School Setting as a Young, Black Woman

> *Well, I've always got stuck with bad teachers. So it would be hard for me to, like, learn math. My last teacher would give us worksheets and have in her head that we understood the stuff on the worksheets and we didn't. She wouldn't go over it and it was kind of hard to understand what she gave us to do.....I hate math but I probably would have looked at it differently if my teachers help me understand it* ~ Veronica

When talking to Black girls about a typical day in their mathematics classrooms, the following sequence of events is a prevalent theme: Check homework, listen to lecture, get new homework or check homework, instructed to read sections in the textbook, and get new homework. Black students are all too often exposed to non-engaging and non-rigorous mathematics curriculum devoid of meaning and any real connections to their lived experiences (Author, 2010). Therefore, many Black girls are not challenged to think beyond facts and procedure and are denied the opportunity to engage in higher-level mathematical thinking. Because of a dehumanized, depersonalized and decontextualized mathematics learning experiences, Black girls like Diana become disinterested and indifferent to mathematics. Diana, a first-year high school student who once loved math shared that, *when I go to geometry it is going to be the worse experience of my life*.

Tarmizi et al (2010) described mathematics teaching as a subject that is "dominated by dehumanisation, depersonalisation and decontextualisation." To dehumanize is to deprive of human qualities. Paula, in the opening passage, spoke of dehumanizing experiences. Paula, like Veronica, Diana, and many other girls around the nation, need mathematics to be rehumanized. While some researchers and mathematics educators have argued for rehumanization, traditional approaches to teaching mathematics are still dominating classrooms around the world. To promote transformation and empowerment among young, Black female students, the Girls STEM Institute was started in 2013. This chapter will describe rehumanizing experiences in math for young, Black female students in the Girls STEM Institute summer camp and how these experiences help foster positive identity development.

Collectively, these experiences are of particular importance to us, the authors, as we are both Black women from the southeastern region of the United States who have through many

triumphs and challenges in school, have found a way to love and appreciate learning mathematics. We have also encountered many peers who are Black and female who feel "defeated" by the slight mention of the term, mathematics. We want to understand those peers. We want to help those peers. We want to help those peers help their children excel in mathematics and beyond. Fortunately, as STEM educators, we can begin this work--through Girls STEM Institute (GSI).

Through GSI we strive to provide Black girls learning opportunities to help disrupt false narratives about their intelligence and who they are as Black learners. This study is just one way to examine the impact of these learning experiences on the identity development of Black girls. From the study's conceptualization to formally writing up findings, our top priority was maintaining the integrity of the girls' voices as they shared their experiences. Therefore, throughout this chapter, we include various quotes and hand written samples of journal entries that captured the essence of our conversations with each participant. Through this work, we hope to provide strategies to help foster an appreciation for mathematics and empower Black girls as learners and doers of mathematics in out-of-school and in-school contexts.

The Study

Afterschool STEM programming, including summer camps, have been found to contribute to improved attitudes toward STEM fields and careers, increased STEM knowledge and skills, and higher likelihood of graduation and pursuing a STEM career (Afterschool Alliance, 2011). Several studies highlight the importance of informal settings on STEM learning, but few focus specifically on Black female (McPherson 2014). To ascertain a better understanding of Black females' informal learning experiences and the impact on their identity

development, we conducted a qualitative study using semi-structured interviews and journal entries.

The sample of 23 Black girls were participants of Girls STEM Institute. During GSI, participants completed journal entries related to a variety of topics including their experiences with mathematics in traditional school settings and their experiences in GSI. For example, students were asked to describe their best and worst math teacher. Interviews were conducted during and after GSI. They lasted between 15 and 30 minutes in duration. The girls were asked a series of open-ended questions which included questions about their experiences in school and GSI, and their mathematics and science confidence and self-efficacy. For example, what is it like being a Black student at your school? Interviews and journal entries were analyzed for common and unique themes using open-coding.

The Experience: Girls STEM Institute

As a former secondary science and mathematics teachers and current science and mathematics teacher educators, we (the co-authors) have heard stories of dehumanizing experiences in math and science classrooms from Black girls and their parents. Stories like the one shared by Antoinette, an elementary student, and Daizha, a middle school student, when talking about their worst math teacher.

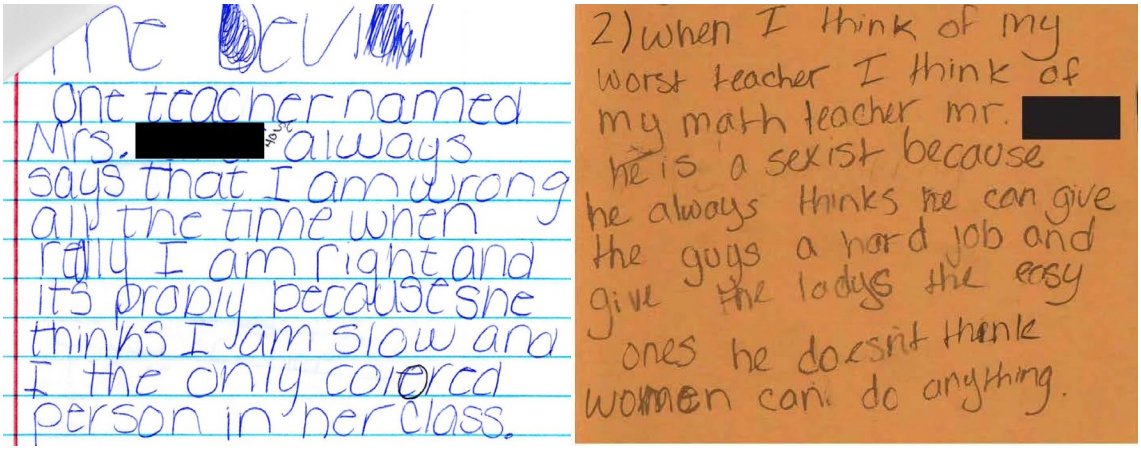


Figure One. Girls STEM Institute journal entries

Girls STEM Institute (GSI)[1] in an informal learning program designed to provide holistic learning opportunities for girls of color like Antoinette who are historically marginalized in STEM fields. The goals of GSI are to improve the achievement, perceptions, confidence and overall wellness and well-being of girls of color and their families. GSI's vision is to transform communities by empowering girls of color, to become leaders, innovators, and educators, who use STEM as a tool for personal and social change. To carry out this vision GSI provides a rich, rigorous, relevant, and supportive context, where participants have the freedom to grow interpersonally and intellectually. Young women are challenged to think critically and deeply and are empowered to use STEM as a tool for personal and social change.

To rehumanize the approach to helping young woman engage in STEM content, GSI leaders focused on very specific elements of the institute experience, including the curricular approach, selection of staff and teachers, institute themes, and prioritization of parent and community engagement. First, the STEM curriculum approach employed by camp instructors utilized a socially transformative framework. Socially Transformative curriculum is a curricular approach introduced by Mutegi that roots itself in 5Cs of mastery in an effort to promote critique

[1] To find out more information about Girls STEM Institute, please visit girlssteminstitute.org

of Western scientific ideas. The 5Cs include content, currency, context, critique, and conduct. The first level of mastery, content, speaks most directly to the subject being taught. Then, currency speaks to the relevance of the subject to human beings. Context speaks to the relevance of the subject to African people. Critique speaks to the importance of helping students use their knowledge of the subject to better understand systemic racism. Finally, conduct speaks to the importance of engaging students in a form of activism on behalf of their community.

For example, a series of lessons called 'Get your money right' were implemented with participants at the camp[2]. During this series of lessons, camp participants used their mathematics and problem solving skills to complete a financial simulation (**content**). This lesson was aligned to several Common Core State Standards for High School Mathematics, including reasoning with equations, interpreting expressions, creating equations to represent relationships between quantities, and several mathematical practice standards that most notably allowed the girls to model with mathematics, reason abstractly and quantitatively, and critique the reasoning of others. For example, on day one, each girl was randomly given an occupation and asked to select her monthly living expenses. She was then asked to set a savings goal for the end of the simulation and create a plan, including a budget, to reach her goal. Figure two shows work samples from a middle and high school participant. They were calculating their monthly salary, living expenses, upgrades to living expenses and savings goal and balance. Throughout the simulation, the girls were asked to reflect on their progress towards their financial goal as well as the progress of their peers.

[2] with parenthetical references to the 5Cs of mastery

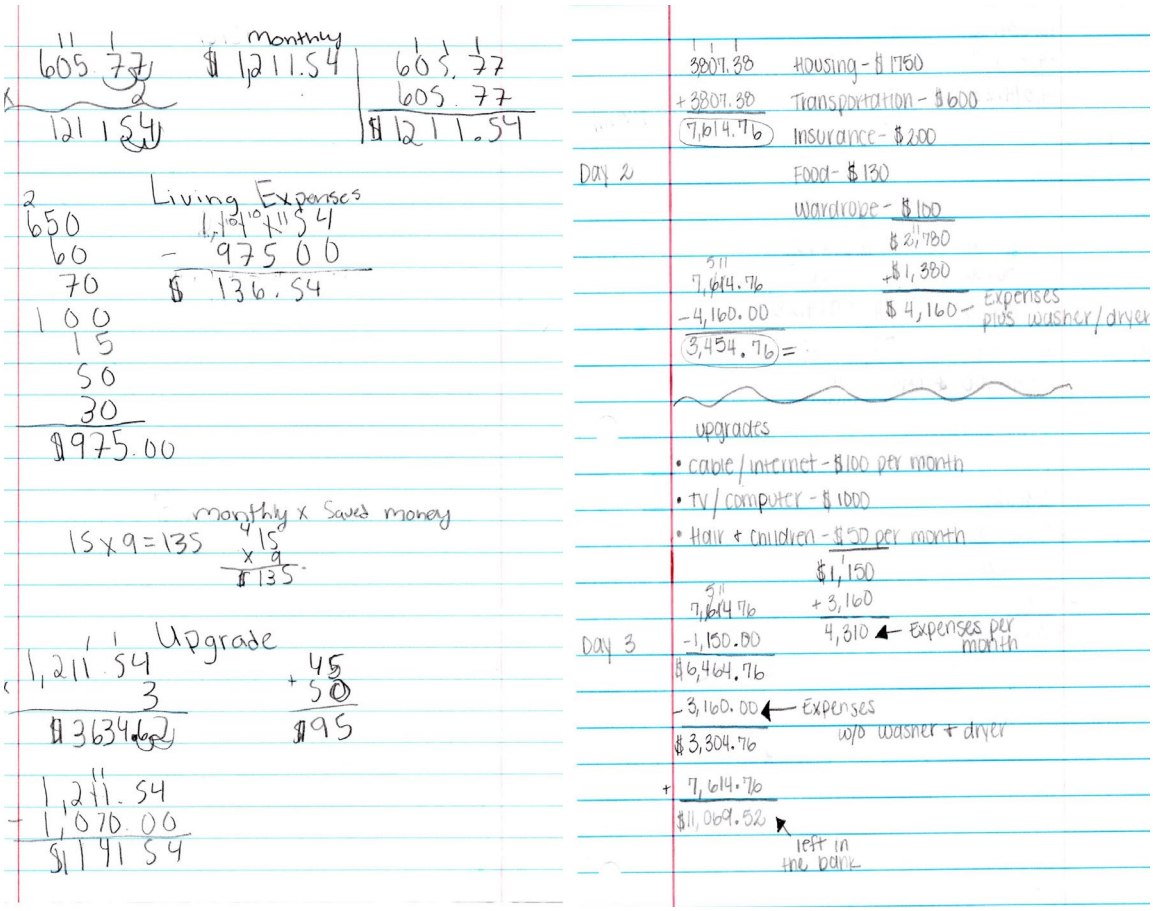
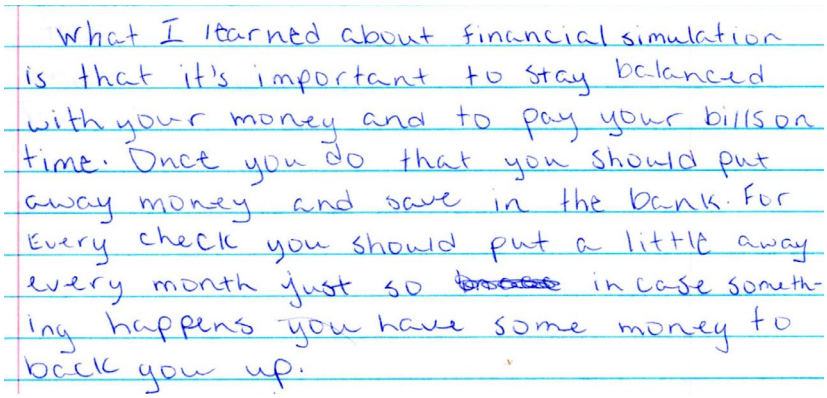


Figure Two: Financial simulation calculations

This simulation was about much more than keeping a household budget (**currency**); it helped young women understand how systemic racism and gender discrimination can serve as barriers to their financial wellness and the financial wellness of their families and communities (context and critique). During the simulation, they are introduced to concepts such as income disparities, budgeting, responsible credit usage, banking practices, predatory lending practices, and earning potential based on education level. The goal of the curriculum is to provide a real-life experience which empowers young women with the tools to understand how to better plan for their financial futures and the future of their families and communities (**conduct**).



What I learned about financial simulation is that it's important to stay balanced with your money and to pay your bills on time. Once you do that you should put away money and save in the bank. For Every check you should put a little away every month just so in case something happens you have some money to back you up.

Figure Three: Financial simulation reflection

Secondly, while it is understood that teachers from an ethnic background can effectively and successfully teach Black girls (Cooper, 2003; Gay, 2000; Ladson-Billings, 1994 as cited in Milner, 2006, page 10), GSI leadership were very intentional about hiring program teachers who reflect the demographics of the girls served in the Institute. Teachers selected by GSI leaders serve as role models who build culturally-informed relationships with participants (Milner, 2006, 93). The leadership also ensures that participants interact with a diverse range of professionals and community members throughout the duration of the program. The access and interactions with a diverse range of professionals (i.e. teachers, chemist, bankers, nutritionist, engineers, nurse) can inform students' professional decisions and help participants visualize possibilities for their lives.

Lastly, GSI prioritizes parent and community engagement because it is understood that it is not enough to support the learning of the Black girl, but families and communities must be engaged for critical systemic and long-term change to occur. Girls STEM Institute's curricular approach, selection of staff and teachers, prioritization of parent and community engagement coupled with an overall holistic approach provides humanizing experiences for Black girls.

These experiences are crucial to fostering positive development of mathematics and science identities.

The Impact

The impact of Girls STEM Institute on Black girls' identity was related to their surroundings and interactions with other girls during the institute, the teachers and staff and the programming curriculum. Some of the major themes emanating from the data included environment of comfort and care, collaboration and relationships, and confidence and empowerment.

Environment of Comfort and Care

> *This is the best camp I've been to because I feel loved and welcomed here instead of like a regular kid who joined a camp. I am glad that I was able to be here because there are no funny acting teachers, like what I mean everybody is treated the same ~ Janice.*

In their interviews and journal entries, participants provided insights into their perception of the GSI's environment. Many of the girls echoed Janice sentiments about the love and hospitality they felt each day. They enjoyed being in environment and building relationships with caring and compassionate peers and teachers. This environment provided Black girls an opportunity to learn and engage with mathematics and science while being their authentic selves. They were not worried about being stereotyped and treated differently because they were Black and female. An environment in which teachers care about the learning and overall well-being of students is what Malloy (2009) viewed as important for improving the mathematical understanding and performance of Black students. This sense of comfort the girls felt made it easier for them to build relationships with the teachers and other girls in program.

Collaboration and Relationships

The camp offered opportunities for the girls to work in collaborative teams to conduct science investigations, solve problems, and discuss phenomenon. Unfortunately, this experience was unlike their traditional school experiences. Veronica shared during an interview: *I've never been with like a great group of girls. Like last week I felt like I could be myself around them [the girls in the camp] without them making fun of me.* The comfortability of the camp environment was also translated to increase confidence in advocating for themselves in times of need.

Like when I guess just being like around some of the girls and then knowing that they don't care if you are wrong or right. They don't care. They share their opinions too. Being around that environment for a while kind of makes you feel like oh, since they are doing it you can do it too. You don't have to like keep all that inside. You can share your opinion about this too. ~ Veronica

Confidence and Empowerment

In their interviews, camp participants also talked about how their participation in the program helped to increase their mathematics and science confidence. Additionally, several young ladies discussed how their overall confidence was impacted. Many girls, shared Kourtney's perspective.

> *I feel like I'm more confident, yeah. I feel like because you guys tell us every day no matter what color you are you can do anything you like. And the people you bring in like that one lady on the first day she was bullied when was young. Like now she is successful and you know she is not getting bullied and everybody looking at her like you did that? So I feel like the people you bring in and the teachers encourage us to become whatever you want in life. ~ Kourtney*

What Teachers Think

Teachers and program managers for GSI have unique perspectives on the impact of the program. Teachers acknowledged the need to provide a holistic approach to educating these young girls, as well as making sound curricular decisions to engage learners in STEM content. A staff member for GSI and a local school district employee compared her experience in a traditional setting to that of GSI:

> *Working in the public school district for years, I am primarily afforded the chance to work with students and parents within the parameters of their educational purposes only. This limitation can sometimes be frustrating and unsatisfying…As it relates to GSI, not only is the student being served educationally and socially, it also encompasses parental participation. Parents as well as students are constantly engaged in processes to improve the students and their families. Some examples include, parents and students attending leadership and development sessions, fun times with one another with something as simple as bowling, and of course several STEM activities. All of these examples are impactful, because they are inclusive in developing a well-rounded young lady, while also keeping the family involved. --Ann*

The sentiments shared by Ann are consistent with literature on black parent involvement (Winters 1994). Additionally, teachers described the content taught during the camp as curriculum with humanistic value. The camp provided opportunities for teachers to "keep it real" unlike the constraints brought by traditional classroom settings. One instructor from the camp describes one of her most positive experiences:

> *One thing I appreciate about the program was the chance to "keep it real". We were able to talk to the ladies about real life issues in a safe and open environment. The girls learned lessons they could use to improve their academics and their everyday lives as well.*

Other instructors shared their thoughts on the appropriateness of the curriculum provided by the camp, as well as the career connections with professionals:

> *The implementation of culturally relevant curriculum permeated this camp. The students were able to connect with what was being taught, and the faculty knew how to work with them on their level. Not only was the program educational, but provided many opportunities for the ladies to be influenced by positive role models. The guest speakers allowed the students to glimpse potential careers and ask questions of professional adults. I specifically remember two detectives, a cosmetologist, banker, and two college professors speaking to the students. All of these speakers were of diverse backgrounds, reflecting the students in program.~Anissa*

The Implications

Providing key experiences for young, Black girls is crucial to fostering positive development of mathematics and science identities. This study provides a model of a rehumanized approach to learning mathematics for Black girls. Designing and implementing rehumanized mathematics is key for several reasons. First, there is a growing interest in STEM at both the national and international level, as well as the persistence of racial disparities in educational achievement among. Secondly, as former math students, we often reflect on our experiences and the experiences of other Black women. This helps us to understand the importance of providing more welcoming opportunities to learn and study mathematics and

science. Opportunities, such as the Girls STEM Institute (GSI) are designed to support the positive development of Black females as learners and doers of mathematics and science. More specifically, GSI provides learners who identify as Black and female an opportunity to develop an understanding of mathematics and other STEM concepts in a meaningful and culturally grounded out-of-school context.

It is evident that the participants benefit from their experiences with GSI. Some of them return year after year. Some of them bring friends. It is a place where they can be girls. Where they can be students. Where they can be learners of mathematics and science and feel human! Imagine that!

> *I am so blessed and honored to be a part of GSI. With its hard work coupled with compassion and tenacity this is an entity that is truly a caring facility for students and families and its positive impact will be felt for years to come. ~ Ann*
>
> *Dr. Crystal Morton has truly created a fantastic program that can affect generations of women to come. She and her staff truly cared about the students and treated them with respect and care. Although professional, the environment was relaxed and fun producing great results. The girls leave valued, cultivated, and educated. ~Anissa*

To advance these practices, further work studying the role of afterschool programs in rehumanizing STEM subjects for students should be explored, as well as examination of longitudinal impact on students' identity and engagement with mathematics.

Positive experiences with mathematics should not be limited to out-of-school programs. Students in mathematics classrooms should be challenged with exploring mathematics with a culturally relevant, socially transformative approach. Teachers can provide these positive experiences by developing a strong rapport with students and making an effort to teach

mathematics in context for Black learners. The 5c's framework helps to contextualize mathematics and rehumanize mathematics learning experiences. To move beyond content mastery, it is necessary for teachers to integrate authentic learning experiences (i.e. simulations, in and out of school community-based projects) and experiences that can be extended to their communities. Also, participants benefited from a collaborative, inviting, and supporting space. Therefore, the classroom environment is of equal importance when rehumanizing mathematics. It is also important for school and district administrators to explore ways to increase the number of teachers who reflect the students that they serve. Implementing these strategies can help transform the teaching and learning of mathematics in schools. Imagine how great it would be to have Black girls talk about their mathematics schooling experiences the way Sophia described her first week at Girls STEM Institute.

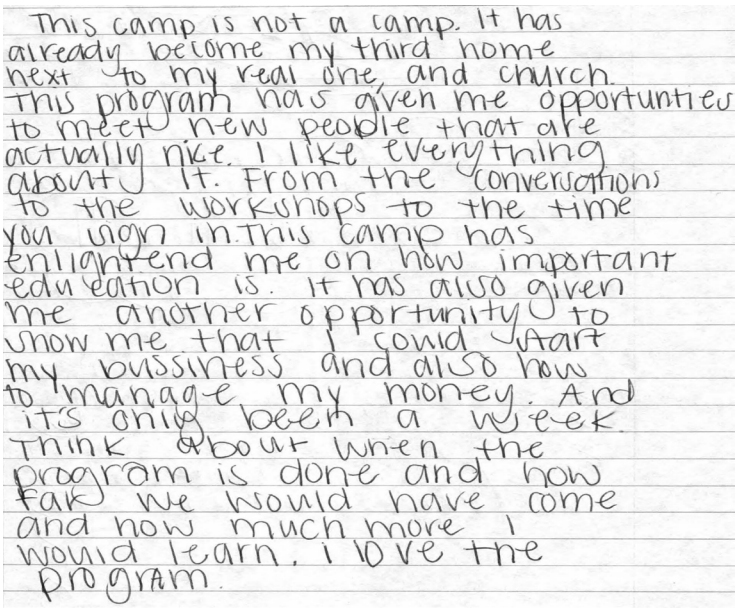

This camp is not a camp. It has
already become my third home
next to my real one, and church.
This program has given me opportunties
to meet new people that are
actually nice. I like everything
about it. From the conversations
to the workshops to the time
you sign in. This camp has
enlightend me on how important
education is. It has also given
me another opportunity to
show me that I could start
my bussiness and also how
to manage my money. And
it's only been a week.
Think about when the
program is done and how
far we would have come
and how much more I
would learn. I love the
program.

Figure Four. Girls STEM Institute journal entry

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