

WORSLEY, TIERA D. Ph.D. Black Love: Exploring How a Politicized Care Pedagogical Approach Supports Youth Establishment of Rightful Presence in STEM. (2022)
Directed by Dr. Edna Tan. 155 pp.

Youth of color are severely underrepresented in STEM which is can be attributed to low socioeconomic status, lack of representation, varying levels of racism faced within different institutions and systems. Without proper support and representation, youth of color can begin to feel that STEM is not a field they identify with or feel they belong. However, Informal STEM programs have been found to be sites of non-traditional STEM learning that support youth of color. This dissertation, based on a three-year study within a local Boys and Girls Club in North Carolina, describes how an informal STEM educator's politicized care pedagogical practice supports Black youth to reauthor their rightful presence in STEM. Using a participatory design-based research approach, I explore how critical relationality that focuses on the integration of youth voice and interest supports youth to develop their STEM-related onto-epistemologies.

The findings of this dissertation indicate that the role of the informal STEM educator has a significant impact on how youth perceive themselves in STEM. This is presented through a multiple case study that focuses on how two Black boys co-created learning opportunities in coding, how informal STEM programs can serve as a Black educational space (a socio-spatial imaginary rooted in anti-Blackness), and a critical autoethnography that looks at what it means to be an informal STEM educator within a community-based setting. Through these findings I surface the criticality for informal STEM educators to have a relationship and develop community with the youth they work with.

BLACK LOVE: EXPLORING HOW A POLITICIZED CARE PEDAGOGICAL APPROACH
SUPPORTS YOUTH ESTABLISHMENT OF RIGHTFUL PRESENCE IN STEM

by

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A Dissertation

Submitted to

the Faculty of The Graduate School at

The University of North Carolina at Greensboro

in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

Greensboro

2022

Approved by

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DEDICATION

I dedicate this dissertation to the generations who came before me. You fought hard to pave the way, I followed the path, and intend to continue paving the way. Know that your sacrifices were not made in vain.

Mattie Bell Hayes – *To Aunt Mattie, my tough old bird, your strength and kindness forever resides in me*

Effie Lucille Melton – *To Aunt Lucille, my constant source of smiles and honesty, your storytelling will forever be a great comfort to me*

Blanche Agnes Hayes – *To Grandma Blanche, my source of overpouring love, your love for others is a value that I will always carry with me*

APPROVAL PAGE

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Date of Acceptance by Committee

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ACKNOWLEDGEMENTS

God *“Seek his will in all you do and he will show you which path to take”*

– *Proverbs 3:6*

Lord I thank you for all that you have done, are doing, and will do in my life. May I continue to follow the path that you have laid out for me and share my wisdom with others.

Family & Community *“Train children in the way they should go; when they grow old, they won’t depart from it” – Proverbs 22:6*

To my family/community, I thank you for always speaking positivity and fortune over me, because of you I have always believed in myself. Even when times were hard I always persevered through.

To my “Uncle Squad” those \$20 for all my A’s have surely paid off and kept me motivated!

Mom & Dad *“Children, be obedient to your parents in all things, for this is well-pleasing to the Lord” – Colossians 3:20*

Mom, you always said “those hands better make you some money one day because they are always on something” but I thank you for always supporting my curiosity. Dad, thank you for always being patient and kind and letting me follow you everywhere to learn.

I thank you both for all the values you have instilled in me throughout these years. Because of you I have been able to touch the lives of many youth and create spaces of Black joy.

Buster & Orlandra *“Have I not commanded you? Be strong and courageous. Do not be afraid; do not be discouraged, for the Lord your God will be with you wherever you go” – Joshua 1:9*

My sweet nephew and niece, I have always strived to be an example that you both could look up to. You both are a core element of my determination and I hope I make you proud. Thank you for the unconditional love and laughs you always share. I know you both will go on to do great things and I will always be behind you.

Elaine & Caitlin *“Two are better than one, because they have a good return for their labor.”– Ecclesiastes 4:9*

CEO Chavis and C-Milla, we have seen each other through so many highs and lows over the years but we always show up with an encouraging laugh. Thank you for seeing me through every step of this journey and always reminding me that I had it and was close to being done. True friendship is hard to find and I am so blessed to have you both.

WOLFPACK IN THE HOUSE!!!!

Christy, *“For if one falls down, his companion can lift him up; but pity the one
Dawn, & who falls without another to help him up” – Ecclesiastes 4:10*

Lauren Christy, one of the first warm welcomes I received in the office. I’m so glad you took me under your wing and guided me in this program. Dawn, my stats/venting/cooking partner. You have welcomed me into your family with open arms and I have enjoyed every minute. Lauren, the first doc student I saw in action and could only think, how do I get to where she is. I truly admire you and your words of wisdom, you are truly an amazing person.

Office 491 *“A time to weep and a time to laugh, a time to mourn and a time to
dance” – Ecclesiastes 3:4*

Office 491, the space of great joys and sorrows. I will forever stand by the statement that doctoral programs are done in community, so thank you all for being a part of mine. Even through the pandemic we still managed to come together in a virtual space and continue being there for each other.

Alison, Arren, David, Dearing, Jennifer, Michelle, Paul, Terry, and Tierney

Matt *“Therefore encourage one another and build one another up, just as
you are doing” – 1 Thessalonians 5:11*

Maker Man Matt. I appreciate all the brainstorming sessions, when I had ran out of ideas. You are such a great friend and it has been a comfort to know that I have your support.

Edna

“I will instruct you and teach you in the way you should go; I will counsel you with my eye upon you” – Psalm 32:8

My academic mom. I entered this program unsure if this was where I belonged. Even when I doubted myself you were always there with “tough love” to get me through it. I appreciate your friendship and guidance throughout this process and hope that I continue to make you proud.

Sara

“Let the wise hear and increase in learning, and the one who understands obtain guidance” – Proverbs 1:5

Mama Bear. I admire your pure heart for supporting others. It has been so fulfilling to work alongside you and learn from you.

**Dissertation
Committee**

“Give instruction to a wise man, and he will be still wiser; teach a righteous man, and he will increase in learning” – Proverbs 9:9

Good mentorship is hard to find and I have been truly blessed to have four strong women come together to build me up and challenge me in the best ways. Drs. Jewell Cooper and Jennifer Adams, I will take these lessons learned with me as I continue to support others.

**Boys and
Girls Club**

*“Show yourself in all respects to be a model of good works, and in your teaching show integrity, dignity, and sound speech that cannot be condemned so that an opponent may be put to shame, having nothing evil to say about us”
– Titus 2:7-8*

To the BGC staff, thank you for your warm embrace over the years. I always feel welcomed and supported by all of you.

To the BGC youth, I want to thank you for the many lessons that you have taught me and for welcoming me into your community. It is always a joy to be at the club and engage with the Black brilliance that illuminates from you all. I hope I have poured into you all as much as you have poured into me. I know you all will go on to do and become great things!

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CHAPTER I: INTRODUCTION

When we look at STEM-based majors and careers Indigenous Americans, African Americans, and Latinos/as are severely underrepresented (Calabrese Barton et al., 2017; Habig et al., 2021). This lack of representation leads to youth of color not wanting to pursue STEM as a career (Calabrese Barton & Tan, 2010; King & Pringle, 2018). When we zoom out and look at the STEM pipeline pathway there are glaring inadequacies for historically marginalized youth. Due to backgrounds of low-socioeconomic status, oppression, and varying levels of individual, institutional, and societal racism (Gutiérrez, 2013). These disparities lead one to ask the question, what and where are the opportunities for historically marginalized youth to become engaged in STEM. Not only become *just* engaged but to feel authentically a part of and represented in STEM. One outlet is by participating in informal STEM programs (ISP). The opportunities for youth of color across ISP include leveraging their funds of knowledge (Gonzalez et al., 1995) and community cultural wealth (Yosso, 2005) to engage in STEM through its multiple entry points (Calabrese Barton & Tan, 2010; Dawson, 2017).

How Informal STEM Learning Addresses the Gap

ISP are defined as STEM-focused learning programs that take place outside of the formal classroom. With less than 5% of our life being spent physically within the classroom, this shows the vital role of informal learning within our life (Bell et al., 2009; Falk & Dierking, 2010). Bell's et al., (2009) criteria for informal learning environments include "learner choice, low consequence assessment, and structures that build on the learners' motivations, culture, and competence" (p.47). The overall goal of ISP is to provide science engagement that is more learner-centered and become a site of possibilities that can support youth to develop their science

identity (Calabrese Barton & Tan, 2010; Calabrese Barton et al., 2017). Bell et al., (2009) identified six strands of science learning that are supported by ISP. These include (a) developing interest in science, (b) understanding science knowledge, (c) engaging in scientific reasoning, (d) reflecting on science, (e) engaging in scientific practice, and (f) identifying with the scientific enterprise. When participants develop an interest in science it motivates them to continue learning about the topic even when the setting changes. Earlier extended exposure to science can encourage younger participants to pursue careers in science (Adams et al., 2014). The goal is that as participants become motivated to engage in science they develop epistemic agency and begin to engage in scientific reasoning. Through scientific reasoning and an authentic experience participants are able to evolve their sense-making. Through this authentic immersion, participants begin to see themselves as part of the community of science and develop their science identity (Calabrese Barton & Tan, 2010; Calabrese Barton et al., 2017).

Research on Broadening Participation in ISP

The National Science Foundation (NSF) has identified broadening participation (for historically underrepresented groups) as one of its priorities in funding research. Their report states they are “especially interested in broadening participation for those groups historically underrepresented in STEM fields such as African Americans, Hispanics, Native Alaskans, Native Americans, Native Hawaiians, Pacific Islanders, persons with disabilities, women and girls, and persons from economically disadvantaged backgrounds” (NSF, 2020, p.7). The Center for Advancement of Informal Science Education (CAISE) has also identified broadening participation in informal spaces for historically marginalized populations as pressing and significant (CAISE, n.d.).

ISP Studies with Historically Marginalized Youth

ISP have made strong efforts to broaden participation however the disparity still exists. To broaden participation, attention must be paid to the roles of race and power in STEM. Habig et al., (2021) shares that ISP are designed to increase the diversity among participants but critiques the lack of attention on race and power. Due to this lack of attention, I draw on ISP studies that are equity-oriented and focused on broadening participation of minoritized youth. I organize these studies according to their informal settings, e.g. museums, out of school programs, summer camps, and makerspaces. I focus on these settings because they are the most common settings where ISP studies are conducted. However due to the variations and intertwining of these settings some studies may overlap. For example, a summer camp may be held in a museum.

Museums

Museums are designed settings that support science learning through learner choice (Bell et al., 2009; Rogoff et al., 2016) and cater to both youth and adults. Learning is designed around multiple exhibits, live animal demonstrations, or short-term programs where learners can choose how they want to interact. These interactions can include, but are not limited to, reading fact labels, touching or observing live animals, or listening to a curator who provides facts or leads a hands-on activity. But generally these experiences are determined by the learner.

A museum study by Dawson (2014) surfaced issues of access and inclusion/exclusion of visitors at museums in the United Kingdom. Dawson noticed that participants who were utilizing the museums tended to be people with privilege. Privilege meant participants who were majority white, middle/upper class, had families and lived nearby. By looking at who was frequenting the museum Dawson began to see who was left out. Dawson proposed a framework for equity within

museums that looks at the relationships between museum practice, infrastructure, and attitudes, behaviors, or habits of those who do not participate (Dawson, 2014, p. 220). Attitudes, behaviors, and habits are the general knowledge about museums such as location, price, or purpose/benefit. Infrastructure is the lack of access to the space combined with a lower status. Practices are the ways of knowing and being within an ISI that can make participants feel “othered” if they are not aware of these hidden rules.

Out of School Programs/Summer Camps

Out of school and summer programs can be classified as enrichment programs for youth in grades K-12 that take place after school hours, over the weekend, or over the summer. (Summer) camps usually have more sustained engagement where programs may last from one to six weeks. These programs can take place at schools or at other locations and are usually discipline-specific, such as STEM, literacy, or the arts. They may also be geared towards interpersonal growth and focus on various life skills. Rogoff et al., (2016) states that afterschool programs are “known to offer rich opportunities for students to engage in consequential learning, develop new identities, and construct new trajectories through participation in informal and hybrid settings” (p. 378-379).

Adams et al., (2014) focuses on the science identity of women of color in a long-term out of school program at a museum called, Lang Science Program (LSP). They did a retrospective approach where participants reflect on their experiences in the LSP and how that developed their science identity. The LSP is a multi-year program designed for youth in grade six that continues until their high school graduation. Participants must apply for the competitive program, meet biweekly over the course of a year, and attend a summer institute. Upon acceptance youth are enrolled in a curriculum that aligns with the museum exhibits. Participants also conduct a science

research project as part of the college and career readiness curriculum (Adams et al., 2014, p. 15). Building a collective identity was identified as an important theme throughout the study. Because of the space that was created for participants through the LSP they were able to nurture their science identities and establish a community with others who felt the same about science. One participant expressed that at school people called her a weirdo because of her love to talk about science but in the LSP program she “did not feel like a weirdo anymore” (Adams et al., 2014, p.16)

A summer program case study by Gutiérrez (2008) focused on a Migrant Student Leadership Institute (MSLI). The MSLI was comprised of primarily Latino/a high school students that looked at a range of academic activities as well as college preparation workshops. This summer program served as a third space where “learning was both vertical and horizontal” (Gutiérrez, 2008, p. 149). Learning vertically traditionally has been looked at along a singular dimension. Gutiérrez pushes on the singular dimension by including horizontal dimensions of learning. With the addition of horizontal learning, we can see learning across settings. Across settings includes home, school, museums, afterschool/summer programs, or other places where youth generate knowledge. Looking at learning across settings is the hybridity that creates the third space. Third spaces serve as transformative spaces where youth can reimagine and challenge what counts as knowledge.

King & Pringle (2018) present a summer program called I AM STEM. I AM STEM is a community-based, non-residential summer program for Black girls in grades 4-8 that focuses on how informal experiences transfer into the classroom. One of the main principles of I AM STEM is to tend to the whole child (mind, body, and spirit) and maintain ‘culturally healthy’ students. Participants of the study were co-constructors of knowledge and worked alongside researchers.

The focus of this study was for Black girls to share their counternarratives about their experiences in STEM. Three meaningful experiences were identified as critical across participants: field trips/authentic STEM experiences, continuation of STEM activities, and the role of race in their formal STEM experiences. Field trips were a key factor for them to engage in STEM learning and expanded their knowledge. Participants also began to look for STEM opportunities outside of I AM STEM that included formal settings and other ISP. When participants reflected on their formal experiences, they felt racialized in their science classroom as they noticed their teacher treated white girls better.

Makerspaces

Makerspaces are sites where participants are encouraged to work collaboratively and be creative and innovative while building digital or physical products (Mersand, 2020; Vossoughi & Bevan, 2014). They can be found in museums, (school) libraries, community centers, and many other places. Makerspaces are hard to define because of the wide range of possibilities of what counts as a makerspace (Martin, 2015; Mersand, 2020). Because of their multiple entry points, they have the potential to link to various disciplines that before may have been constrained (Mersand, 2020). Makerspaces, as a part of the "Maker Movement", have become increasingly popular in recent years. This can be attributed to President Barack Obama's Nation of Makers initiative that pushes youth to become more involved with technology (White House, 2014). While the maker movement serves as a site of possibilities and encourages everyone to make and be a maker it brings up the question; *what counts as making and for whom* (Calabrese Barton et al., 2017; Peppler et al., 2016)? However, not all opportunities to make in maker programs acknowledge these histories or support such meaningful making. Issues of race and power have led to structural inequities and forms of oppression that limit opportunities to make in ways that

matter (Gollihue, 2019). Making has long been a part of history in every culture but the recent resurgence of making is being led and associated with white, middle-class, males (Calabrese Barton et al., 2017; Vossoughi et al., 2016). Historically marginalized youth are presented with the opportunity to leverage their funds of knowledge (Gonzalez et al., 1995) community cultural wealth (Yosso, 2005) by challenging dominant discourses and practices (Bajaras & Bang, 2018; Gollihue, 2019).

For example, Calabrese Barton et al. (2017) study looks at how youth of color navigated the process of making to develop their maker identity. The program Making 4 Change (M4C) is set in a community-based makerspace that takes place after school. M4C supports equitable and consequential STEM-rich making. Researchers use critical ethnography to observe youth's making process over time. The goal of the program was for participants to create prototypes that utilized renewable energy sources and to document, via video, their process so that they could share with others. Calabrese Barton et al. (2017) poses the questions "what it means to make (identity), what one can make (the making process), and who is allowed to make (maker community)" (p. 31). In posing these questions youth can choose what it means for them to become a maker and develop their maker identity. Because of the nature of the community space some youth would attend M4C as a means of spending time with their friends and simply hang out. This openness also encouraged other youth to engage in the space. One youth, Fall, struggled with school but loved "reporting about the world" (Calabrese Barton et al., 2017, p. 24). Fall was very invested in her community's projects, and created a little free library. Through these engagements she became a reader, writer, and an engineer and later a self-identified "blogger extraordinaire" (p. 32).

In the above makerspace example we see the role of community in making. The makerspace was located in a community-based Boys and Girls Club. We also saw youth generating community-based projects that were meaningful. The sustained engagement over time also supported youth to navigate the iterative nature of making. The research on ISP has shown how sites are designed to support youth's STEM identities by having a positive experience with science learning. These studies took different theoretical approaches that included sociocultural, identity, third space, counternarratives, and equitable and consequential. From these examples, we see the critical role ISP have in broadening participation by supporting historically marginalized youth in developing their STEM-related identities. It is also important to see how sustained engagement over time and a stable community of peers and facilitators were also important for youth to develop their identities as well. Participants felt that they were a part of the community and had choice and agency in how they wanted to engage.

Gaps in ISP

From the literature we see the opportunities for youth of color across ISP include leveraging their funds of knowledge and community cultural wealth to engage in STEM through its multiple entry points. Informal STEM programs are increasingly focusing on and being designed to broaden participation for historically marginalized youth to develop their STEM-related identities by having positive experiences with STEM learning. However, I argue that just because an ISP is classified as informal does not equate to a positive engaging space for participants. The research on historically marginalized youth in ISP has primarily focused on how ISP are designed to support youth's STEM identities but what are the gaps in the research. When I think about ISP I focus on two key aspects; how programs are designed to support participants interests and learning, and how the educators pedagogical practices support youth

learning in that space. There is limited research that looks at the role of informal STEM educators within ISP. The role of the informal educator is crucial for implementing the ISP design to support youth in developing their STEM-related onto-epistemologies.

Earlier Bell et al. (2009) provided criteria for ISP that included “learner choice, low consequence assessment, and structures that build on the learners’ motivations, culture, and competence” (p.47). Callanan et al (2011) and Rogoff et al. (2016) add to this criteria by listing common features of informal learning and their *differences* across settings. These criteria include the; (a) extent to which they focus on play, (b) extent to which they involve contributions to “real” productive goals, (c) extent of focus on instruction or guidance, (d) extent of role differentiation among participants, (e) extent to which activities have collaborative versus individual goals, (f) connection of the immediate activity with a larger community, and (g) specific cultural practices and topics of interest of the cultural communities engaged in the setting. Informal STEM educators must create opportunities for unstructured play (exploring) (Davis et al., 2020). Unstructured play is important because it affords youth the opportunity to explore what it means for them to engage in STEM-related activities. Having an *authentic* or *meaningful* experience in STEM supports learners to increase their interest in STEM. Informal STEM educators play a large role in encouraging youth to have equitable and consequential STEM-related goals . When STEM is in alignment with youth interest they are more engaged rather than doing the same activity that was assigned to all. By incorporating youth interest it prevents “keychain syndrome” (Blikstein & Worsley, 2016) where everyone does the same thing.

Going back to Rogoff et al., (2016, p. 360) features that organize informal learning, many of these features are in direct correlation with the informal STEM educator. Are youth being

positioned in ways that make them receivers or givers of knowledge? To what extent can they contribute to the knowledge that is being produced or shared? In community-based ISP the activities tend to be more collaborative in nature where the community (informal STEM educator included) works together to support learning (Calabrese Barton et al., 2017). Lastly the informal STEM educator should have knowledge about the communities they are working with. By bringing in culturally relevant material youth begin to see themselves represented in STEM. Below I share three studies that show the importance of the role of the informal STEM educator in supporting youth in an ISP. The settings of these studies are a museum, community-center, and an afterschool program. Pattinson et al., (2018) provides a quasi-experimental design that focuses on the impact of trained facilitators on museum visitor engagement. King (2017) is a narrative inquiry about youth's STEM learning experiences and the characteristics of teachers who encouraged their participation and engagement in their ISP. Stewart & Jordan (2016) is a qualitative case study focused on one youth and how her learning opportunities were opened up and truncated by the facilitator.

Pattinson et al., (2018) developed the REVEAL facilitation approach as part of an initiative to develop effective facilitation strategies for museum participants. The REVEAL facilitation approach in the context of family learning at math exhibits comprises the exhibit experience, and how it informs the responsive facilitation thus shaping the museum exhibit experience. Because of the nature of the social interactions between the facilitators and museum visitors, facilitators must actively notice how families are engaging. Responses from visitors found that facilitators should be prepared to balance content-based information with visitor goals that support free-choice learning (Falk & Dierking, 2002). Depending on what facilitators noticed while observing and interacting with visitors would inform how they engaged in

conversation. The findings suggested that museum facilitators enhanced the exhibit engagement by increasing the quality of engagement through use of the REVEAL facilitation strategies.

Visitors appreciated richer experiences that involved meaningful interaction.

King's (2017) study is part of a larger study on I AM STEM. When participants were asked about their informal educator experiences in I AM STEM, three criteria emerged as key to Black girls having positive experiences. These criteria included; responding to the girls' needs/building a community of learners, professional interactions with parents, and encouraging critical thinking and creativity. Participants highlighted the importance of their informal educator supporting their academic success and engaging in their STEM learning. They pointed out that informal educators were receptive to their needs, created a positive learning environment, and appreciated when educators challenged them in their thinking (King, 2017, p. 11).

In Stewart and Jordan's (2016) study one of their participants, Nina had a negative experience in her afterschool engineering club. They had many tools and resources to support participants learning, but the design of the program, specifically the design of the educator's role, created tension. The main design rule was that club participants had to do *all* of their own work, and educators were not allowed to build/program anything for participants (Stewart & Jordan, 2016, p.146). Educators were only allowed to support participants when they would ask direct questions but educators could not offer step by step instructions. They described their roles as helpers/question-answerers and they could make suggestions but participants would have to follow it up with more elaborate questions. Nina's group was working on a problem but were not making progress. The educator had identified where they were messing up but because of the program design was unable to show participants their error. The educator suggested rereading the instructions with careful attention on the first page but Nina's group still misinterpreted the

solution and continued work that was unproductive. The educator identified that more scaffolding was needed for participants but in the moment they could do nothing.

The above examples show both the affordances and constraints of informal STEM educators when looking at participants learning and experiences in ISP. Pattinson et al., (2018) highlights how museum visitors' experiences were enhanced by a receptive facilitator. King's (2017) participants shared how critical it was to have an informal educator who supported their STEM learning but also cared about them. These are both positive examples of how the informal STEM educator can support STEM learning in ISP. However, with Stewart & Jordan (2016), we see how the informal STEM educator created a negative experience for a participant. Nina became frustrated by not knowing how to proceed and the facilitator (due to programming rules) could not support Nina's learning. While the program did provide a fun engaging environment to create robots it lacked the facilitation design that was needed to support learning for Nina.

Conclusion

Upon the review of the literature, we see how ISP serve as an opportunity for historically marginalized youth to become engaged in and see themselves represented in STEM. While the designs of ISP aim to broaden participation we cannot miss the opportunity to address race and power in STEM. Informal STEM educators of ISP are tasked with ensuring that race and power are not left out of the design, especially when working with youth of color. As an informal STEM educator I have an educational responsibility to ensure I support the learning of youth while also fostering a learning environment that values youth's community cultural wealth and collective sense-making in authentic, youth-centered ways.

CHAPTER II: CONCEPTUAL FRAMEWORK

From the literature review, we see the affordances of informal STEM programs for historically marginalized youth. Informal STEM programs are increasingly focusing on and being designed to broaden participation. Studies have been conducted that show how informal STEM programs have been designed to be sociocultural, develop STEM-identity, create third spaces, offer counternarrative, and be equitable and consequential, while addressing race and power. However not enough information is known about the role of the informal STEM educators in these programs. To further look at the role of informal STEM educators I developed the conceptual framework, Black Love.

Why Black Love?

What does Black Love mean? Specifically what does it look like to show love to Black youth in STEM spaces. Jenkins (2021) defines anti-Blackness as “the socially constructed notion that Black people are non-human, inherently problematic, and disposable, structures the spatial arrangement and social imaginaries of every facet of American society” (p. 111). Dumas (2016) also states that “Black is not only misrecognized, but unrecognizable as human, and therefore there is no social or political relationship to be fostered or restored” (p. 14). STEM tends to be taught from a westernized perspective directly making these spaces rooted in anti-Blackness. Black Love pushes back on these Eurocentric white heteropatriarchal canonical norms that are embedded in science/STEM spaces. Black Love provides insight on how I conceptualize the fostering, restoring, and humanizing of Blackness within STEM spaces. To restore, foster, and humanize Black youth within STEM means supporting Black youth to find joy in STEM-rich making while loving themselves, especially their Blackness, throughout the process (Love, 2019;

Worsley & Roby, 2021). hooks (1994) describes this phenomena as classroom community and how as teachers our capacity to generate excitement is deeply rooted by our “interest in one another, in hearing one another’s voices, in recognizing one another’s presence” (p. 8). To show youth Black Love is to validate their varied, non-traditional interests in STEM and to humanize youth by creating critical community while working alongside them. In doing this youth feel loved and cared for thus supporting them to find educational freedom within STEM.

Development of Black Love

Black Love is emergent of my lived experiences within formal and informal settings, on the groundwork within the community, and current facilitation of STEM to Black youth. I began this framework with the question, “*What values and pedagogical practices would I need someone to enact if they took over my position*”? By reflecting on my own pedagogical practices, I created a list of practices and values that I found imperative. From the list of values and practices developed I was able to identify two main tenets. These tenets include STEM-related onto-epistemologies and critical relationality focused on the integration of youth voice and interest. I then identified frameworks that were best representative of these two main tenets. The two frameworks that were in alignment were rightful presence (Calabrese Barton & Tan, 2020) and politicized care (McKinney de Royston et al., 2017).

Politicized Care

Politicized care (McKinney de Royston et al., 2017) is developed from culturally relevant pedagogies (Ladson-Billings, 1995) and culturally responsive teaching (Gay, 2002). Both culturally relevant teaching practices highlight the importance of relationships between teachers and students where teachers can use their professional capital to support the whole child.

McKinney et al. (2017) developed politicized care as a framework from their research study that

focused on positive student-teacher relationships in the Manhood Development Program (MDP) between Black male mentors and Black male students in middle and high school. For the high school students, MDP was offered as a course and for the middle school students, it was offered as an afterschool program. The program's purpose was to "increase attendance, lower suspensions and expulsions, promote self-awareness, and help cultivate healthy identities" (McKinney de Royston et al., 2017, p. 9). Politicized care emerged as a collective consciousness that Black educators shared for their Black students.

Politicized care consist of four tenets that include (a) political clarity, (b) communal bonds, (c) potential affirming, and (d) developmentally appropriate (McKinney de Royston et al., 2017, Table 1, pg. 8). Political clarity is the transparency about the nature of oppression that influences how Black educators and Black youth interact. Communal bonds are the community developed by educators and youth that push to disrupt systems of inequality. Potential affirming is maintaining high expectations of youth and recognizing what they can do rather than focusing on culturally-based deficits. Developmentally appropriate is the space created that sees and acknowledges the vulnerability of Black youth. For my conceptual framework, I draw from political clarity, communal bonds, and potential affirming.

Rightful Presence

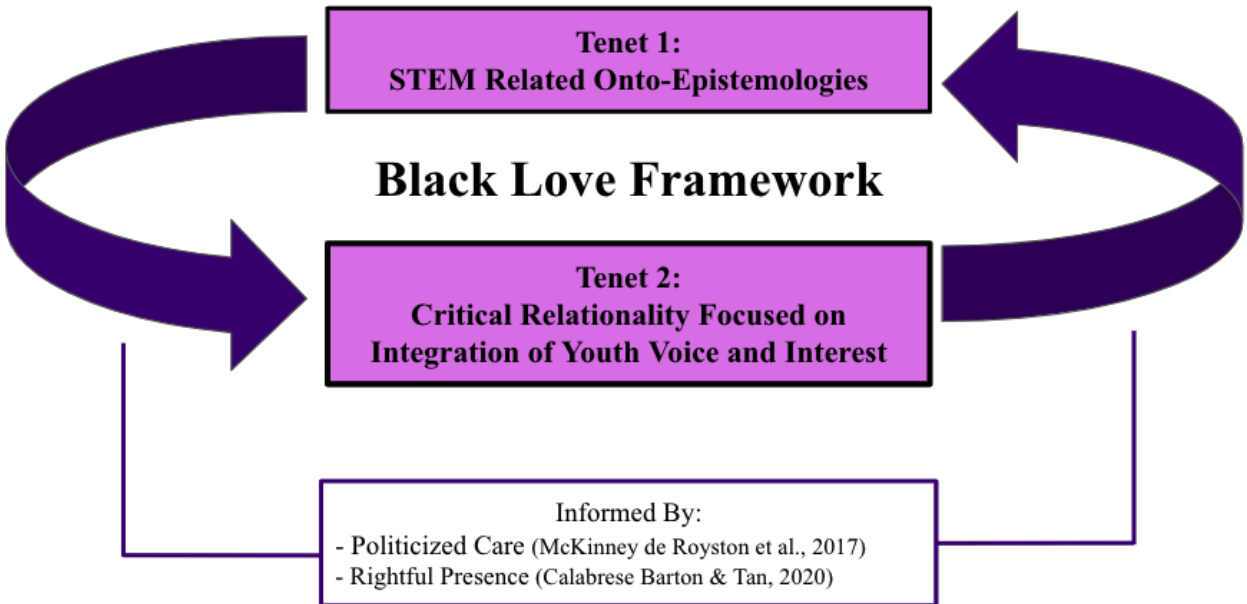
Rightful presence (Calabrese Barton & Tan, 2020) "focuses on the processes of reauthoring rights towards *making present* the lives of those made missing by the systemic injustices inherent in schooling and the disciplines" (p. 4). Rightful presence goes beyond youth having access to a space as an equitable opportunity. It asks the question if youth have been extended the right to feel that they can authentically be their whole selves within spaces. In the article they highlight a vignette where Amir, a 12 year old, Black boy was engaged in a unit

where the class focused on forensic science investigations. In the last session Mr. A, the teacher, had students analyze their data to convict the right criminal. Mr. A shared the importance of fairness and how to use data as evidence. Amir then said “Unless you’re Black! If you’re Black, you’ll be convicted” (Calabrese Barton & Tan, 2020, p. 3). Caught off guard by the statement Mr. A, liked his passionate statement but suggested another setting would be better suited for the comment. Mr. A later explained that he did not know how to navigate the statement in the moment in front of the class, but acknowledged that Amir was right. This vignette shows the importance of how pedagogical practices that make present and problematize historical context can lead to discussions about the racialized dimensions of science education, which in turn can lead to students feeling like they have more of a rightful presence (Calabrese Barton & Tan, 2020, p. 3).

Rightful presence has three tenets; political struggle, rightfulness established through presence, and culture of disruption. Political struggle is the challenge by which educators to extend the rights to reauthor, to youth. Rightfulness established through presence makes known the intersections of injustice in youth’s lives and disciplinary learning that lead to new possibilities. Culture of disruption is moving from the traditional practices seeped in dominant ideology through the reauthoring and extending of rights that lead to shifts in classroom

hierarchies of power. Next, I explain in further detail the tenets of the Black Love framework (Figure 2.1) and how politicized care and/or rightful presence supports those principles.

Figure 2.1: Black Love Framework



Tenet 1 – STEM-related Onto-Epistemologies

STEM-related onto-epistemologies are the intersections of who someone is (ontology) and how they develop STEM-related knowledge (epistemology) (Barajas-López & Bang, 2018; Tan et al., 2019). The two are inextricably tied together and are constantly working with and against each other (Warren et al., 2020). I name STEM-related onto-epistemologies as the first tenet because in programming, I lead with teaching STEM practices. As youth are introduced to these STEM practices they begin to sense-make what it means for them to engage in STEM. In designing for programming, I must consider *what* and *who* are being valued, and towards what end. Supporting these various methods of engagement help youth to develop their STEM identities (Calabrese Barton & Tan, 2010). Youth develop their STEM identities through

interactions with various STEM tools, having opportunities to iterate their work, and an educator to encourage and support their efforts (Calabrese Barton & Tan, 2018). To support youth as they develop their STEM-related onto-epistemologies I use three subtenets: 1) validating various methods so youth see themselves as doers of STEM, 2) high expectations of youth's STEM expertise and ability to do rigorous STEM now, and 3) active noticing.

Validating Various Methods so Youth See Themselves as a Doer of STEM

The process of learning science has traditionally been leveraged in alignment with the scientific method that includes observing, asking questions, forming hypotheses, making predictions, testing that theory, and being able to iterate that theory. However, science is not meant to be static and neither is the process of learning science. Engaging in STEM requires trial and *error*. When youth engage in STEM they often focus on being correct or doing something the *right way*, but it is important for youth to know that messing up is a key part of the learning process (Calabrese Barton et al., 2017; Heredia & Tan, 2020). I argue that knowing what do not work is just as important as knowing what does work. Youth come from different backgrounds and draw from different funds of knowledge (Gonzalez et al., 1995) when sense-making how to move forward in STEM. When engaging in STEM there are multiple ways to reach solutions and solutions are informed by youth's onto-epistemologies. The learning environment should be reflective of that process and support youth learning STEM in varied ways. As youth sense make what it means for them to engage in STEM they begin to see themselves as doer of STEM. Seeing themselves as a doer of STEM is key to imagining their future selves (Calabrese Barton & Tan, 2010; Roberts, 2010).

High Expectations of Youth's STEM Expertise and Ability to do Rigorous STEM now

Maintaining high expectations of youth's ability to do rigorous STEM now, sets a tone for the learning environment and reinforces the positioning that youth "can" (Ladson-Billings, 1995; McKinney de Royston et al., 2020). High expectations set a norm that youth not only *do* the work but that they put forth the effort and take pride in their work. My axiological standpoint of high expectations is that I value youth as well as the work they produce. This models for youth that they also should put value in their work because it is an extension of themselves. When youth share their expertise with others they begin to *see* the value in their work and their abilities in STEM. I acknowledge how the societal positioning of being Black and engaging in STEM requires youth to produce work of higher quality. Youth can become discouraged when they feel that they cannot do something however, they should not stay in a discouraged mindset. I make sure to consistently encourage youth by working with them through their frustrations. By maintaining high expectations youth can learn from these moments and continue their work. It is important for youth to know that they are not alone in their learning and that I am there to ensure they get what they need to produce rigorous STEM.

Active Noticing

As a result of the weekly sustained engagement of programming, I have the opportunity to notice how youth learn, work, and create connections in their learning environment (Gay, 2002). A large portion of noticing is done through observation, however I push for *active* noticing because the observations must then be used to support youth's learning. Watching youth as they engage in STEM supports me to know conceptually how they are thinking about the activity and informs my pedagogical moves. Knowing how youth are thinking about STEM supports just-in-time (JiT) teaching (Calabrese Barton & Tan, 2018) and identification of what culturally "STEMulates" youth in STEM.

JiT Teaching.

JiT teaching is a responsive form of teaching to what youth need in the moment to get them to the next step (Calabrese Barton & Tan, 2018). This can look like learning a specific STEM skill set, navigating problems when youth feel that they have messed up or want to quit, or expanding on ideas they have brought to programming. JiT requires educators to be extremely observant by knowing what youth are focusing on. Knowing youth's thoughts and ideas allows educators to be responsive to their needs. Their needs may require the educator to quickly learn a new practice

Culturally “STEMulating” Skills.

When engaging youth through STEM, it is important to provide more than culturally relevant material. For example when youth are presented with a STEM-based project they will find a theme that is culturally relevant to them. This could include creating a project that is specific to their community or a topic of interest. Culturally relevant material serves as an entry point that engages/hooks youth because they can find their interest represented within STEM. It becomes culturally STEMulating when youth learn various STEM practices because they are motivated by their interests. For example once youth have identified a theme that is culturally relevant they are then STEMulated to learn more STEM-based practices that will bring their projects to fruition.

For STEM-related onto-epistemologies I pull on tenets from both frameworks. From politicized care (McKinney de Royston et al., 2017) this is represented through political clarity and potential affirming. From rightful presence (Calabrese Barton & Tan, 2020) this is representative of political struggle, rightfulness established through presence, and culture of disruption. In validating various methods so youth see themselves as a doer of STEM there is

political struggle and sharing the burden of reauthoring what it means to know and do STEM (Calabrese Barton & Tan, 2020) by acknowledging their connection to STEM with experiences of oppression in STEM (McKinney de Royston et al., 2017). In maintaining high expectations of youth's STEM expertise and ability to do rigorous STEM now this represents potential affirmation (McKinney de Royston et al., 2017). Holding high expectations of youth shows their capability of learning and pushes back on deficit narratives. When youth begin to see themselves as a current and future doer of STEM it makes present what it means for them to engage in STEM. Positioning youth as experts of their work disrupts the hierarchy by re-authoring who holds knowledge (Calabrese Barton & Tan, 2020), and pushing youth to see that they are the holders of knowledge. Active noticing is represented by potential affirming and rightfulness established through presence.

Tenet 2 - Critical Relationality Focused on Integration of Youth Voice and Interest

Critical relationality means that “my humanity, my integrity, and my dignity are rooted in my willingness to safeguard your humanity, secure your integrity, and protect your dignity” (Olivares & Tucker-Raymond, 2020). As an educator, it is important that I recognize the power and influence that I have (King, 2017; King & Pringle, 2018) with the youth I work with. While I am not their formal teacher, they still hold me to a standard as their educator. I must be aware of how my actions and thoughts can influence youth. For this reason, I include youth in the planning/designing of programming (Calabrese Barton & Tan, 2018; Vakil et al., 2016). When planning for programming there should be space for the integration of youth voice and interest. This reduces power dynamics and gives youth the agency and confidence to speak up and advocate for their learning. By integrating their interest into their STEM practices they make their projects their own. In formal settings, science tends to be taught traditionally which can

make lead youth of color to not be interested or identify with STEM (Calabrese Barton & Tan, 2018; Gutiérrez, 2008; Mensah, 2016). To implement youth interest the educator should plan collaboratively with youth and create critical community through the humanizing of youth.

Collaboration in Planning

It is important for youth to feel that they have agency in their learning. I include choice in programming by including youth in the planning process. By including youth in the planning of programming it reduces the power dynamics between the educator and youth. Youth are more engaged with STEM-based projects when they feel connected and it is something that they want to do (Mensah, 2016; Calabrese Barton & Tan, 2018). I create opportunities for youth to reauthor rights by supporting them to develop agency (Calabrese Barton & Tan, 2010, 2020). For youth to feel that they have choice it must first feel like a safe space for youth to share their interests.

Flexibility/Adaptability

When working within informal community-based environments it is important to be open and flexible. The nature of working within community-based spaces is very nuanced, because while I have control over STEM programming I still have to work within the constraints of the club and other researchers. These constraints can include resources, time, and space among other that contribute to programming not going as planned. When planning does not go as intended I must quickly adjust to those changes. Being flexible also includes receiving feedback from youth, and using it to improve programming (Escudé et al., 2020). I encourage both positive and negative feedback about their concerns or their interests. However, receiving feedback is not enough, I must also incorporate the feedback. It is critical to apply the feedback that is given by youth because the program is designed for their learning. Initially, youth may feel uncomfortable

with speaking up about what they want to see happen in their learning. When youth feel that they can be open and honest about what they want in their learning this is a sign of rightful presence.

Transparency/Accountability

As the educator, it is important to be transparent and accountable to youth by being open and honest. Being transparent with youth can lessen the power dynamics and support youth to feel like they are more than just participants. Transparency holds me accountable to youth as they develop their expectations of me. Accountability includes showing up consistently and letting youth know when I will not. It also includes being honest when I do not know the answers to what they are asking but assuring them that I will work with them to find out. When I began work with a new group of youth (as the group changes yearly), I witnessed how having someone who was inconsistent created a distrust with youth where they did not want to engage with “new staff”. Because of this on the first day, I was transparent about when programming would be held and when it would be cancelled. As a new adult in their community saying this was not enough, there had to be action behind the words.

Critical Community Building through Humanizing Youth

Critical community building includes communicating across difference, attending to power, and engaging in ongoing reflexivity (Bettez & Hytten, 2013). Humanizing youth supports youth to be their authentic selves and welcomes their lived experiences to support their learning (Bartolomé, 1994; Ladson-Billings, 1995; ross et al., 2016). Within the STEM programs humanizing youth is enacted by acknowledging youth’s feelings, learning their names and using

them, actively listening when youth share their experiences with you, and creating space for critical conversations that youth want to engage in.

Acknowledgment of Feelings

There can be an expectation that youth should be “positive” and always ready “to do”/engage in activities, but this is not always the case. It is normal that after an almost eight-hour day and bus transportation youth may be tired, irritated, or just need a break. When youth come to programming I check-in with them to see how they are doing. Usually, they respond by saying that they are tired or just not in the mood (for STEM), and I suggest they walk around, get water, or ask them how I can help them get through it. Once we discuss what is needed and make the necessary adjustments, they are ready to get to work (Brown-Jeffy & Cooper, 2011).

However it is important to state that acknowledgment of feelings is not limited to how youth feel physically or emotionally but also includes how they feel about STEM. For example if youth are unsure of what it means for them to be in STEM I acknowledge this by working with them to understand how they see themselves engaging in STEM. To acknowledge feelings requires active listening. When youth decide to share parts of their daily lives with me it is important that I actively listen to them to develop understanding and to show that I value what they have to say. As youth discuss parts of their daily life it can provide insight into their interest. When I listen to youth I can build on their interest and find or suggest ways they can integrate that into their STEM projects. This opens up opportunities for them to engage in STEM in culturally relevant and STEMulating ways (Ladson-Billings, 1995; Roberts, 2010).

Learning and Use of Names

Names are our identities, and it is important that I make the effort to not only learn youth’s names but to make sure that it is spelled and pronounced correctly (Kohli & Solórzano,

2012; Roberts, 2010). The youth I work with are predominately Black and some of their names are not considered common to the dominant culture. Their names sometimes contain punctuation and may be hard to read upon the *first* try. As someone who also experiences the challenges of having a *unique* name, it is imperative that I address youth the correct way.

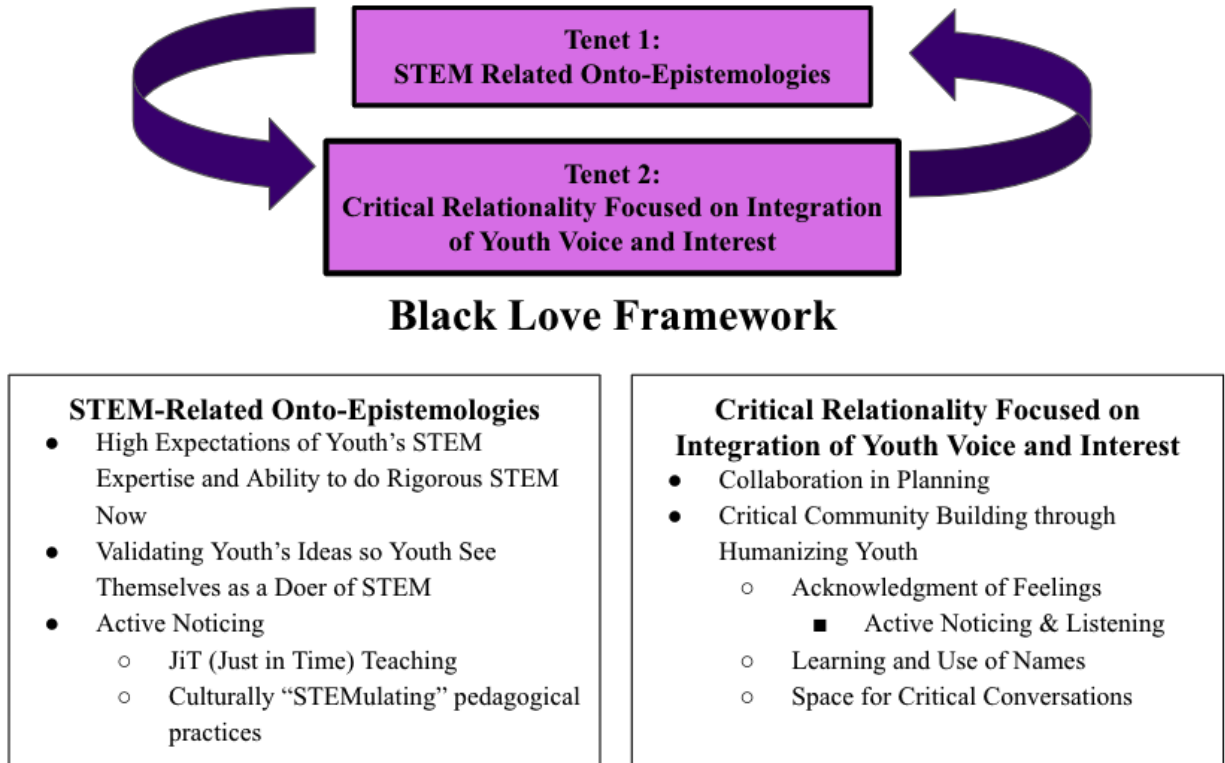
Space for Critical Conversations

Lastly, it is important that youth are able to discuss issues that relate to race and power as it affects their livelihood (Calabrese Barton & Tan, 2020; King & Pringle, 2018). These can be difficult conversations for educators to hear from youth. I emphasize that when these conversations take place it is *not* for the educator to solve the problem that youth are discussing but instead to create space for the conversation. Critical conversations can be difficult and uncomfortable for educators to hear but youth have the right to be listened to.

Critical relationality focused on integration of youth voice and interest is seen through the three tenets of rightful presence (Calabrese Barton & Tan, 2020). By collaborating with youth during the design process, I am disrupting the traditional relationalities of classrooms. Collaboration leads to power being re-authored as youth develop agency in their learning (Calabrese Barton & Tan, 2010). As they develop agency, youth establish rightfulness through presence. Youth are then able to show the intersections between their lives (interest) and STEM. From McKinney de Royston et al., (2017) the relationship between educator and youth is reimagined through politicized care. The two tenets; political clarity and communal bonds show the importance of these relationships. I care for youth and the work they produce because I see youth for who they are and who they can be.

STEM-related onto-epistemologies and critical relationality focused on integration of youth voice and interest are in an ongoing cycle (Figure 2.2). Programming always begins with teaching youth STEM practices. As youth sense-make what it means for them to engage in these

Figure 2.2: Black Love Framework - Extended



practices they find entry points to integrate their interests. Incorporating their voice and interest creates a vision of how youth want their STEM projects to be. This then drives them to learn more STEM practices because they want their vision to become reality. Thus creates the ongoing cycle of wanting to learn more STEM practices to support their interests. By integrating their voice and interests into their learned STEM practices they begin to establish their rightful presence in STEM.

Conclusion

As educators, whether informal or formal, we have an educational responsibility to ensure we support the learning of *each* youth while also fostering a learning environment that values STEM-related onto-epistemologies and critical relationality focused on integration of youth voice and interest, in socially just ways. Together the educator and youth have fostered a community where youth feel comfortable to express themselves and have strong ownership. These youth work together, support each other, and know when they speak up and make suggestions their voices are being heard by me.

CHAPTER III: METHODOLOGY

Purpose of the Study

From my conceptual framework, it has taken about four years of sustained engagement to observe features pertinent to fostering a positive successful learning environment for youth. I define a positive successful learning environment as one where youth feel that they have established a rightful presence and where they see the value of what they bring to programming (Calabrese Barton & Tan, 2010, 2020; McKinney de Royston et al., 2017). I propose the following questions to contribute to under-researched areas in informal STEM learning environments. The overarching question looks at how the two main tenets of my conceptual framework (STEM-related onto-epistemologies and critical relationality focused on integration of youth voice and interest) come together to support historically marginalized youth in developing their rightful presence within informal STEM. From the literature, we see that informal STEM environments have been identified as sites for youth of color to broaden their participation in STEM (Calabrese Barton & Tan, 2018), however, there is limited research on the interconnectedness between the educator, the environment, and youth.

Research Questions

- What does it mean to engage in informal STEM teaching & learning when the environment is undergirded in the principles of Black Love?
 - What does it look like when youth are provided “space” (e.g. access to materials, human resources, social networks, new ways of “doing” STEM-rich making) that leads to youth authoring a rightful presence in STEM?

- What are the ways that critical relationality supports the integration of youth interest and youth voice in developing youth's STEM-related onto-epistemologies?
- What are the rightful presence-related markers of success for youth as a result and the implications for adult facilitator roles to support such?

The first sub-question focuses on how youth utilize their informal environment to develop their rightful presence in STEM. Specifically, I look at how youth access materials and leverage their human resources/social networks to create new ways of engaging in STEM-rich making. When youth first engage in STEM within an informal context it is a new experience for them. Youth must navigate, for themselves, how they want to interact with resources, both human and material. It is important to provide time and space for youth to sense make what it means for them to engage in STEM-rich making in ways that are meaningful to them.

The second sub-question looks at how critical relationality (Olivares & Tucker-Raymond, 2020) supports the implementation of youth interest and youth voice in the development of their STEM-related onto-epistemologies. The aim of this question is to look at how the informal STEM environment co-created supports youth to see themselves as doers of STEM (Calabrese Barton & Tan, 2010). I look at critical relationality because it supports the educator to reimagine relationships and recognize the importance of relationality in our planning for their learning (Olivares & Tucker-Raymond, 2020). The focus of research in informal STEM environments usually focus on how youth have access to different types of tools and locations that support youth to increase their knowledge on certain topics by creating physical or digital projects (Stewart & Jordan, 2016).

The third sub-question looks at the markers of success for youth as a result of the tenets of the conceptual framework (critical relationality focused on integration of youth voice and interest and STEM-related onto-epistemologies) and ways for the educator to support these markers. Within informal STEM environments, especially spaces where youth have agency in their learning, it is important for educators to be flexible and adaptable to support the needs of youth.

Research Design

Since my research questions are informed by educator-youth interactions and disruption of power dynamics I use participatory design research (PDR) for my research design. PDR is a type of design-based research (DBR) that addresses and works at reducing power dynamics by actively involving the community in the design process (Bang & Vossoughi, 2016; Vakil et al., 2016; Zavala, 2016). Bang & Vossoughi (2016) describe the PDR paradigm as; “the domain of the “researched” is expanded to include the relational, pedagogical, and design-based activity of researchers themselves (Bang et al., 2010; Vossoughi & Escudé, 2016), creating potentially new openings for reciprocity, accountability, and the de-settling of normative hierarchies of power” (p. 174). DBR has been critiqued for its focus of attention mainly on learning and disciplinary areas only (Engeström, 2011; Vakil et al., 2016) which fails to address race and power. By only focusing on “fixing” a problem there is less focus on the interactions between all participants involved. PDR re-mediates who has power within the setting by dismantling and disrupting traditional power hierarchies where the researcher is positioned as the expert.

Vakil et al. (2016) identified the establishment of trust and gaining access as two critical tensions in research relationships that need to be addressed. In one of their case studies, they supported the Oakland Unified School District in a reform effort that was specifically created for

African American males. This program was called the African American Male Achievement Task Force and supported Black male students to develop positive identities and increase academic engagement. The new superintendent, Mr. Smith (a white male) appointed Mr. Chatmon (a Black male) as the director of this program. Mr. Chatmon was a well-known person in the community. The community was initially skeptical about the undertaking of such a large but beneficial program. Others within the community viewed this as Mr. Chatmon being set up to fail. As one of the researchers (Dr. Nasir) watched this unfold she offered her support and resources to Mr. Chatmon. Their connection of a shared community and mission was also shared politicized trust in each other. Trust was identified as a key dimension of the relationships created with partners and that trust was politicized because of the recognition of power and race.

In Bang & Vossoughi (2016) they are particularly interested in how critical historicity, power, and relational dynamics influence partnering and forms of learning that emerge (p. 174). Critical historicity looks at how political and theoretical histories are intertwined with participants' onto-epistemologies. Relational dynamics focus on the consequential connection between the subject-subject (youth-educator). They argue that this connection is often left out in DBR because of the focus mainly being on the learning experience between the subject-object (youth-learning). By shifting the focus to subject-subject interactions it opens up the possibilities of asking how, why, and for whom iterations/decisions are being made in the design (Bang & Vossoughi, 2016; Engeström, 2011)

From the two examples above engaging in PDR requires trust, access, historicity, power, and relational dynamics. Trust and access are part of relational dynamics because developing a relationship requires time and access. For my research study, I work with a local Boys and Girls Club (BGC). I have worked with BGC for 4 years which has afforded me the opportunity to

build a strong rapport with youth and staff. Below I provide context about the site and both STEM programs.

Context

Boys and Girls Club

BGC is an organization that provides afterschool programs for youth. Youth who attend range in grades from K-12, and are predominately Black. There are two main categories of youth the first being Reaves and the other is the Teen Center. The youth in Reaves are age 5-12 and when youth turn 13 they transition to the Teen Center. The Teen Center is housed at the same site but not connected to the main building. BGC is open Monday-Friday during the school year and over the summer. During the Covid-19 pandemic youth did their virtual schooling at BGC for the whole day, 8 A.M.-5 P.M. I facilitate two STEM programs at Reaves and the Teen Center. The program at Reaves is called Green Club and includes youth in grades 6th-7th. The program at the Teen Center is called the Teen STEM Program and youth are in grades 7th-12th.

Green Club

Green Club takes place on Tuesday afternoons from 4:15 P.M. -5:30 P.M. with some days lasting until 6 PM per the request of youth on late buses. The room where Green Club is held also doubles as the technology room. In this room there are laptops, tablets, a 3-D printer, 2 long white tables, 12 adjustable blue chairs, and a whiteboard. Two of the walls have tall glass windows where we hang youth's work. Participation in Green Club is not required but staff usually have all 6th and 7th graders attend. There are usually about 12 youth who attend but out of those 12, about 8 are consistent each week. This can fluctuate depending on which youth are playing sports, the school they attend, or if they are just starting at BGC. If youth join BGC at a

later date they are always welcome to join Green Club. I am one of three researchers who facilitate this program.

As youth enter we greet them and check-in with how they are doing. Some days youth are in deep discussion about varying topics, so we listen and at times jump in to ask clarifying questions. Once they have settled down we then go over the goals for that day. We ask if there are any questions, address those questions, and then begin work by passing out materials. As youth work, we circulate the room to observe what they are doing. When youth get stuck or need clarification of how to proceed they call out to us and ask for assistance. At the beginning, some youth are not comfortable with asking for help so we do more observation to see how the work is coming along.

When we near the end of programming we ask youth where they are at with their project and assure them that they will have the following week to continue their work. Sometimes youth can become stressed that they have not finished but we let them know that this a weekly program so there will be time for them to get through it. On the whiteboard, we post short reflection questions to gather their thoughts and opinions about what they have done. Youth then get into groups of 2-3 and answer these questions by recording a video on the iPads. After they have provided feedback they clean up their workspace and we provide a snack for them. Once they receive a snack they are free to go but sometimes youth will stay to ask questions, ensure things are clean, or to keep working.

Teen STEM Club

The Teen STEM Club took place on Monday from 4:30 P.M. - 6 PM. Youth trickle in as they get off the bus and begin with their homework. I originally started the program 15 minutes earlier but youth informed me that they needed to work on their homework first so I pushed the

time to 4:30 P.M. to accommodate. I usually arrive at 4 P.M. to begin set up since there is not a designated room for programming. This also provides time to converse with the youth who do not have homework. I am the educator for this program and about eight youth consistently attend programming. Teens are not required to attend programming either and some youth choose not to participate. If youth choose not to participate I always let them know that they are welcome to join when they are ready. The Teen STEM Program has a similar format to the Green Club where I start with the goals for the day, begin work, walk around helping where needed, gather feedback, and then provide a snack. When I started working with the Teen STEM Club they were searching for a Teen Director for the center. The Teen Center had gone through a few directors in a short time period which led to youth being resistant to build connections with new adults because they felt they were temporary. The BGC Director informed me of this saying they may be resistant because they felt very close to the last director who had just left and inconsistencies of other adults who had worked with them.

I have worked with the Green Club since 2018 and began work with the Teen STEM Club in 2019. Both programs ended abruptly in March 2020 due to the Covid-19 pandemic. Programming resumed virtually in September 2020 with both groups. Due to technical issues within the Teen Center, the BGC Director and the Teen Director requested I resume programming with the teens in-person. I resumed in-person programming with the teens in October 2020.

Research Methods

To address my research questions, chapter 4 is a multiple case study focused on two youth in Green Club, Donovan and Jabria. Case studies are used to develop an in-depth understanding of a situation. It is bounded by a specific event, activity, or program and allows

the researcher to analyze for key themes to understand the case (Glesne, 2015). Chapter 5 shares three vignettes about the co-creation of the Teen STEM Program. The vignettes highlight three critical moments that were key to establishing what the STEM club would look like Chapter 6 is a critical autoethnography where I reflect on my role as an informal STEM educator. This critical autoethnography looks at how my own lived experiences have influenced my pedagogical practices. Below I explain these methods in further detail.

Youth-Focused Multiple Case Study

Donovan is now a 14-year-old (age 11 during time of study), Black boy in ninth grade at a public high school. He has participated in the STEM program for about 2 years and is currently participating in the Teen STEM Club. Unfortunately at the beginning of the Covid-19 pandemic Donovan was one of the youth who was unable to attend BGC for about six months. Because of my conversations about Donovan with BGC staff they were aware that I was fond of him and alerted me that he would be returning. When he returned to BGC he was unable to attend STEM programming due to the restrictions on how many youth could be grouped together and becoming acclimated to participating in-person at BGC again. Although he was not in STEM programming from 2020-2021, he did stop by programming one day just to speak with me and let me know that he was back at BGC.

Jabria is now a 15-year-old (age 12 during time of study) Black boy in tenth grade at a public high school. He has participated in the STEM program for about 2 years as well. Just like Donovan, his participation at BGC was disrupted during the Covid-19 pandemic. Jabria did continue to come to BGC throughout the pandemic but because of the restrictions of how youth could be grouped he was not able to participate in consistent programming. Due to the number of

youth in the Teen program and youth not being permitted in groups of larger than 10, Jabria received programming once every 3 weeks.

Selection of Participants

I focus on Donovan and Jabria because of all the youth in Green Club that year (2018-2019), I spent the most time working with them through their coding. Donovan and Jabria both had challenges in navigating what it meant for them to develop an “I can code” identity. While they both were able to develop this identity near the end of programming (May 2019), the ways in which they navigated developing these identities varied.

PDR

PDR would be used to look at the co-constructed culture of both STEM learning environments (middle school aged youth and teens). This would include looking at the design aspects, relationality between facilitators and youth, socio-spatial-material aspects and learning trajectories of youth. Design aspects would focus on the design of the STEM program that would include rules and expectations of programming. Relationality between facilitators and youth would look at the relationships developed over time. Socio-spatial-material aspects include the resources, both human and material, available to youth and how they interact with these resources. The learning trajectories of youth will focus on how youth are developing their STEM identities and developing an understanding of STEM-related material. These components work together to create a learning environment where youth feel they have a rightful presence.

Critical Autoethnography

To navigate how my experiences inform my pedagogical practices, I employ critical autoethnography. Critical autoethnography emphasizes intentionality and self-critical awareness (Boylorn & Orbe, 2014, p.6). It helps to understand lived experiences of people in context by

examining oppressive conditions and social realities. Through my lived experiences, I seek to understand how culture and power come to the forefront of my informal STEM context. Through self-interrogation and cultural accountability I use my lived experience as epistemology to provide a counter-narrative of what it means to be a Black woman, informal STEM educator (Boylorn & Orbe, 2014; Toyosaki, 2018).

Data Sources

Fieldnotes

I have collected weekly fieldnotes since September 2018 accruing more than 150 sessions worth of fieldnotes. Fieldnotes include participants attended, summary of what happened, detailed accounts of youth's (youth I work with) learning processes, memorable moments, and pictures. I tend to work with the same youth each week so I was able to follow them over time. This supports me to add excerpts that can connect themes or identify a trajectory for in youth. With the Teen STEM Program I continued to focus on youth but also began to take notes of how I was planning for programming. Because I was the only educator and the program was just beginning I wanted to keep details on which activities I was using, how original plans were adapted, and how youth were responding to the activities. I also created a planning document where I wrote down programming goals each day.

My fieldnotes are very descriptive similar to that of a story because when I go back to read my notes I can vividly recall what was happening and why decisions were made. This also supports the research team when we share notes. At the end of the programming year, I compile all of my fieldnotes into a merged document. I merge the fieldnotes so that when I am reviewing for data analysis I can have all of the notes together and be able to follow emerging themes.

Artifacts

Artifacts that have been collected to support the proposed research questions include pictures, videos, and scans of youth work and vlogs (video blogs). Vlogs are used for youth reflection of their work each week. Usually 2-3 questions are posted on the board for youth to answer before programming ends for that day. 35 vlogs were collected from 2018-2019. Youth work that has been collected thus far are both digital and physical. The first year (2018-2019) of programming the focus was on coding and we utilized the coding program scratch through MIT (Massachusetts Institute of Technology), ozobots, and makey makey. Scratch is a block-based coding program that is used online. A classroom account was created to save youth's work as well as saved to Box, a secure program to save files. Ozobots are small robots that utilize color-coding on paper. Codes are created by using a combination of the colors red, blue, green, and black that then direct the ozobot where to go and what to do. MaKey MaKey is a kit that turns everyday objects into controllers that was used to support games created via Scratch.

In preparation to analyze youth's scratch coding data I created an extensive overview of their work that included a picture (screenshot) of their game and of their coding, the scratch codes that were used and the number of times used as well as any modifications to the code, and notes about coding such as name, whether coding works or is unfinished, and any other skills used to create the game that was not a pre-made code. A second document was also created that looked at which codes were used, if these codes were changed from the default, and what they were changed to. I also included an analysis of scratch skills that included imported background images and sounds, changing of characters or backgrounds, changing an already made game, or pulling code from other sources. fieldnotes were also used to create these overviews of code to create a timeline of how youth progressed with scratch over time. For the coding of the ozobots

this was usually done on paper. Youth would create ozobot “tracks” that would include their coding that was created for the ozobot to follow. Pictures, scans, and videos were taken of the tracks. When using MaKey MaKey pictures and videos of youth’s controllers were used. Because of materials (such as fruit) used by youth some controllers were unable to be kept.

In the second year (2019-2020) of programming, the artifacts from the teens group were both digital and physical. They included e-textiles, painted electrical art canvases, and tinkercad designs. E-textiles are electrical elements added to embroidery. Electrical art were painted canvases designed by youth that included circuitry with LED lights. Tinkercad is a 3D modeling software where youth create structures to be printed in 3D. A class account via tinkercad was created for youth to save their digital designs but I also saved their designs on a USB drive. This year (third year, 2020-2021) the Teen STEM club created a physical airplane prototype with the use of 3D pens and legos.

Group Interviews

Focus groups have been conducted with youth a few times after a specific event to gather their opinion on how they felt it went or to gain understanding of how they view the STEM that they do in the program in comparison to at school. Some of these events have included Science Everywhere and the Coding Festival. Science Everywhere is an event hosted by UNCG where youth presented and taught about the games that they had coded to the public. The Coding Festival was an event held at the BGC where youth taught about the games they had created specifically for other BGC members.

Group interviews were conducted with youth during the summer of 2021. The only criteria for the group interview was that youth had worked with me for at least one year in-person. I specify in-person because some youth worked with me virtually for one year and the

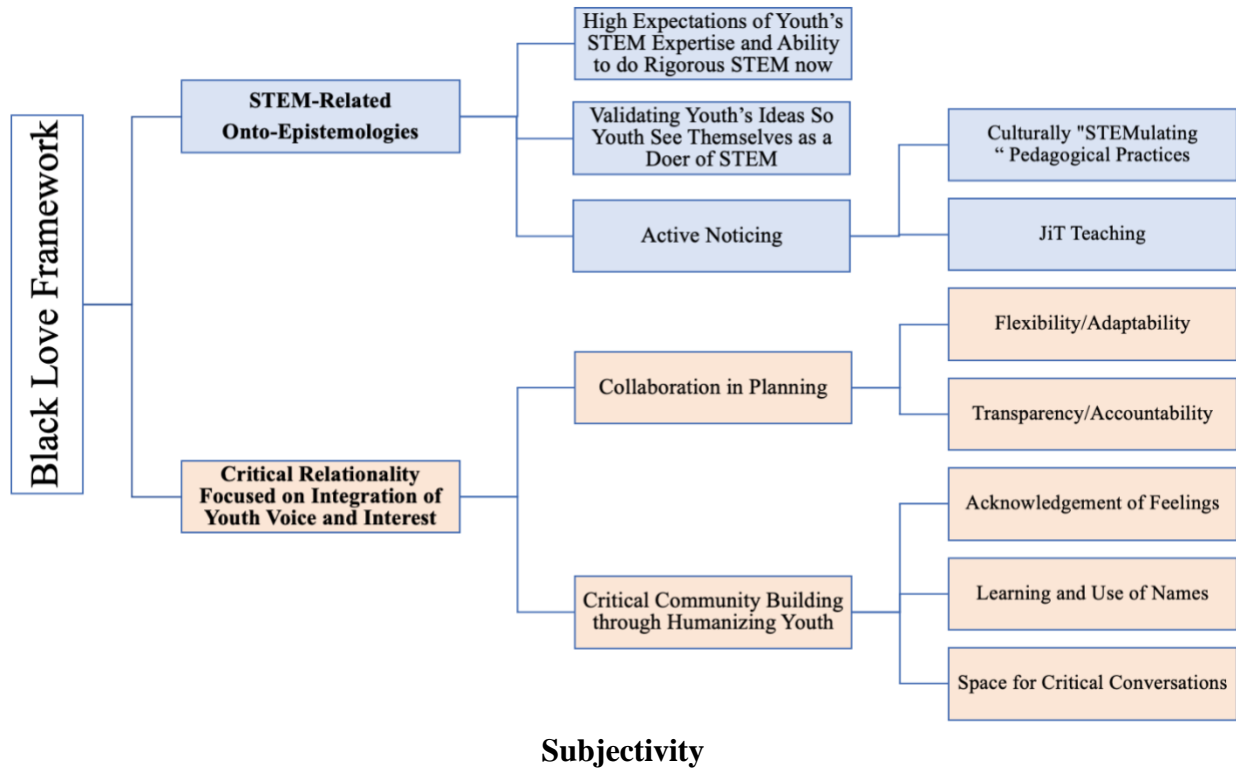
dynamic of that experience was different. A protocol was created based on the Black Love framework to see how youth were interpreting the framework and what actions they felt I took to enact the framework. To be ethical, as these questions were about me, Dr. Edna Tan conducted the group interviews. A total of ten youth, split into two groups of four and six were interviewed. Interviews were in-person lasted for about 20-25 minutes. When I listened to the interviews I took note of responses and who they came from. I pulled responses that aligned with the three Black Love subtenets that were identified (collaboration in planning, critical community building, and validation of youth's ideas). These responses were then used to explain the importance of youth agency in decision making, stability in critical community, and youth actualization of STEM capabilities from youth's perspective.

Data Analysis

For chapters 4 and 5 data were analyzed using grounded theory (Glaser, 1992) to identify key moments where youth were supported through the tenets of Black Love. What surfaced were two case studies (chapter 4) and three vignettes (chapter 5) that were key in understanding the possibilities of Black Love. Fieldnotes were coded using the Black Love coding tree (Figure 3.1). No distinctions were made between main tenets and subtenets, however if a subtenet was identified the adjacent parent codes were automatically included as well. For example, if just in time teaching was coded then active noticing and STEM-related onto-epistemology were automatically included. I looked across the codes to see which codes were frequently used. After coding the fieldnotes I would triangulate findings and add details to other data sources (group interviews, artifacts, video/photos). I would then go through all data again to identify themes and patterns where critical relationality through youth voice and interest supported youth in

developing their STEM-related onto-epistemologies. Due to the format of this dissertation each chapter will include a more robust explanation of data analysis.

Figure 3.1: Black Love Coding tree



As the researcher, I am fully aware I brought my own beliefs, perceptions, biases, and experiences to the study. Peshkin (1988) expressed the importance of being aware of one's subjectivity. Subjectivity is large in my role as a researcher because of my own intersecting identities of being a Black woman who has always been engaged in STEM yet constantly looked for a rightful presence in STEM. As a child my greatest joy was to put things together and take things apart to understand how they function. This led me to a pursue an engineering degree at a public university in North Carolina. This research is personal for me because I throughout my formal education (K-20) I have always had to fight to be in spaces that have not traditionally been occupied by people of color. As an undergraduate pursuing mechanical engineering I was

told by a professor that if I could not “hack” physics then I could not “hack” engineering so I should just change majors. I could not believe how someone could be so cold in their approach to direct me away from engineering without any further questions. After this encounter I switched to agricultural and environmental technology because my interest were in physically being able to put things together and this major offered me that. This encounter showed me how important it was to actually be doing what I was interested in rather than fighting to hold an “engineering” title. When I began working with youth in the area of STEM I wanted to ensure that the space they were entering felt like they were welcome as well as their ideas. Being a Black woman in this research space, I have formed a close relationship with the youth in my study. During our weekly sessions youth have shared many aspects of their lives including both joy and frustrations, especially at school. I am more than just a researcher in this space, I am a friend, encourager, and mentor.

Validity

A key component of a research design is to conceptualize validity threats and strategies to deal with such (Maxwell, 2012). Two validity threats that I must confront are researcher bias and reactivity. As a Black woman, I bring my personal experiences into my research which may influence how I interacted with participants. Addressing these biases early allowed me to find methods to eliminate my biases. Because I am fully immersed in the research as well as facilitation of programming it was important to not react and influence the research setting. Because of my long-term involvement with youth and staff I am able to increase value and accuracy, which contribute to the validity of my study. To further ensure validity I describe in Table 3.1, how my study establishes qualitative rigor according to Tracy’s (2010) big-tent criteria.

Table 3.1: Big-Tent Criteria (Tracy, 2010)

Criteria	Evidence
Worthy Topic	There is limited research that looks at the role of an informal STEM educator. Research tends to focus on the design of the program and the artifacts that youth make.
Rich Rigor	Data has been collected through weekly sustained engagement over a 4 year timespan. Researcher has collected four year's worth fieldnotes, artifacts, photos/videos, and group interviews.
Sincerity	Because of the PDR approach researcher acknowledges power dynamics through self-reflexivity and is transparent with youth about steps taken (Peshkin, 1988).
Credibility	Researcher consistently iterates on data sources and works with research group for triangulation to improve validity (Glesne, 2016; Maxwell, 2012).
Resonance	Research highlights the importance of the role of the educator within a community-based space. The design principles that the facilitator enacts are specific to working with historically marginalized youth in STEM
Significant Contribution	The Black Love framework was created to analyze data that emerged from fieldnotes taken over time. Black Love can be adaptable when working with youth to make sure their voices and interests are heard.
Ethical	Because of the community-based setting researcher has taken time to develop relationships with participants and ensure that youth feel that they have a rightful presence in their STEM program.
Meaningful Coherence	Purpose of study, conceptual framework, and methodology are all in alignment (Glesne, 2016; Maxwell, 2012).

Ethical Considerations

Approval for this study was given through the Institutional Review Board (IRB) and by the BGC. Parental and student consent documents were explained, signed, and collected. This was critical to protecting the youth participants in this study.

Limitations

There were limitations of this study as I am heavily involved in many aspects of the research. One limitation was my ability to follow each youth during programming. Because of my role as facilitator and researcher I struggled to observe everything that was happening during programming. To help with this I had access to other researchers field notes, photos/videos, and student artifacts. Due to the sustained nature of the program I was also able to go back to participants and ask them to explain anything that I may have missed. Another limitation was the inconsistency of all youth participants. If youth did not come to programming I could not collect any data. However since I was involved in the space for about 4 years I was able to collect sufficient data on other participants.

CHAPTER IV: I'M NOT GIVING UP ON YOU: REIMAGINING LEARNING

OPPORTUNITIES FOR BLACK BOYS TO DEVELOP THEIR CODING IDENTITIES

Introduction

Informal learning environments provide unique opportunities for youth of color to engage in STEM learning and doing that are non-traditional. In Bell et al., (2009) criteria was provided for informal learning environments that included “learner choice, low consequence assessment, and structures that build on the learners motivations, culture, and competence” (p. 47). Rogoff et al. (2016) adds to this criteria by including (a) extent to which they focus on play, (b) extent to which they involve contributions to “real” productive goals, (c) extent of focus on instruction or guidance, (d) extent of role differentiation among participants, (e) extent to which activities have collaborative versus individual goals, (f) connection of the immediate activity with a larger community, and (g) specific cultural practices and topics of interest of the cultural communities engaged in the setting (p. 360). In this chapter I focus on two of these criteria; instruction/guidance offered and the cultural practices and topics of interest. These criteria are explored through two Black boys’ journey in learning to use a block-based coding program and how I supported their learning. For these reasons I ask the following research questions:

1. What learning opportunities are created for Black boys, as they critically reflect and take political action in coding their own games?
2. How does the establishment of politicized trust with the informal STEM educator support youth development of critical agency?

Literature Review

To frame these case studies, I draw on literature from socio-spatial relationalities and politicized trust. I draw from socio-spatial relationalities because I focus on how two Black boys are creating learning opportunities for themselves based on what they experience within their informal community-based STEM space, which is housed in a local Boys and Girls Club (BGC). Politicized trust is used to closely examine the relationship developed between these youth and their educator and how that influences the learning opportunities that are created.

Learning Opportunities informed by Socio-Spatial Relationalities

Learning opportunities are informed by one's connections and access to specific places. We come to know places by the experiences that we associate with places, however, experiences are not always static and can be continuous or (re)edited individually (Ma & Munter, 2014). Those experiences in turn determine the connections we develop with places and can be informed by space/time spent in a place, types of learning that occur, or physical/mental boundaries to name a few. Ma & Munter's (2014) study focuses on how learning opportunities (or access to participation) are designed within socially produced spaces. Their study took place at a skate park where they observed how the space was socially produced through skaters experiences and how that setting and activity led to learning opportunities. When skaters utilized the skate park they would (re)edit how to use the park for themselves to learn various skating skills. For example, when one skater wanted to learn a particular trick, they would go to specific locations in the skate park to observe the trick as well as receive feedback on their own execution of the trick.

Rubel et al., (2017) examined learning opportunities by looking at how a set of spatial tools supported youth to understand their geographies of opportunity. Geographies of

opportunity are “spatial patterns in opportunities to learn that are especially significant for urban education” (Rubel et al., 2017, p. 645). Spatial tools were used to provide counterstories that challenged hierarchies of power. The spatial tools used included an oversized floor map, interactive geographic information system (GIS) maps, and participatory mapping. Together these tools supported youth to become critical spatial citizens through fostering critical reflection “reading the world”, political action “writing the world”, and critical agency. Critical reflection supports youth to read the world by becoming political subjects. This then leads to political action where youth write the world to have greater influence (Rubel et al., 2014). Reading the world and writing the world contribute to youth seeing themselves as citizens who make a difference. From Rubel et al., (2014) and Ma & Munter (2014) I see the importance of how socio-spatial relationalities shape learning opportunities for youth. Youth’s sense of self within spaces and how they come to know it plays a larger role in how they choose to create learning opportunities for themselves.

Politicized Trust

Looking deeper at how these learning opportunities are created, I must also give attention to the relationships established with specific learning environments. While I know the strength of youth experiencing positive relationships in learning environments, I must address the role of race and power in these student relationships (Vakil & McKinney de Royston, 2019). Politicized trust addresses this colorblindness by focusing on race and power in relationships. The three main components of politicized trust includes; (a) understanding each other; (b) respect for one another; and (c) solidarity with one another (Vakil & McKinney de Royston, 2019, p. 550). Political understanding is having knowledge of the racialized history of students’ backgrounds and seeing that they are an individual as well as a member of many communities. Respect is

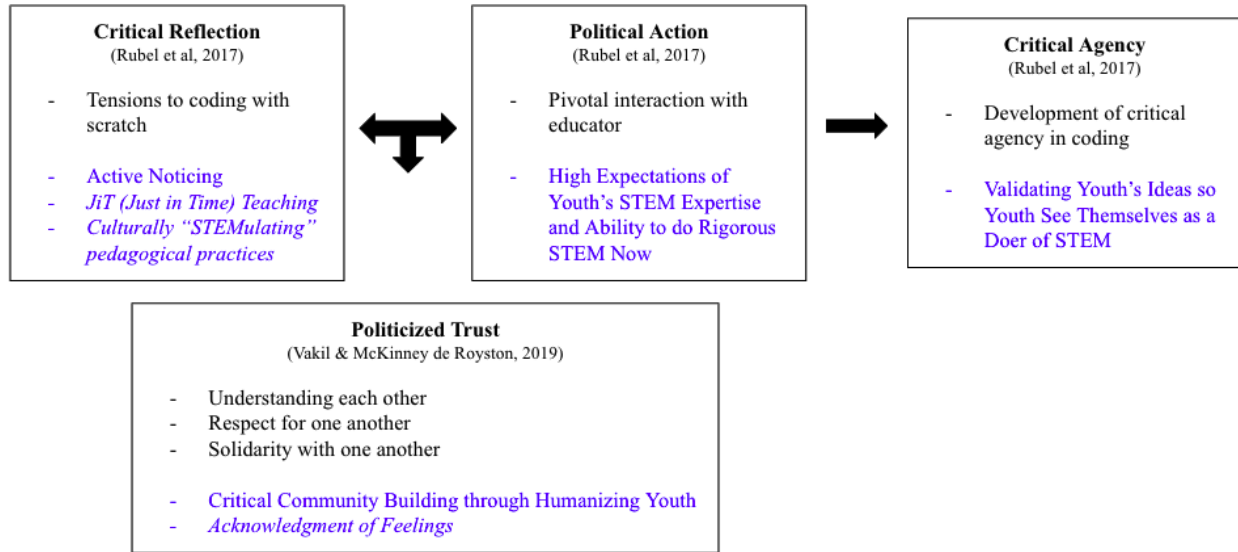
acknowledging students' ways of being as well as their boundaries. It is important to explain that boundaries are fluid, unclear, and not limited to physicality. Lastly, solidarity is having a shared socially just mindset with students.

Theoretical Framework

Ma & Munter (2014) expressed that there should be more explicit investigations into the interactions between materials and social spaces (p. 239). I expand on this by focusing on how the socio-spatial relationality of place, materials, and educator-youth interactions supported youth to code in an informal community-based STEM program, that is undergirded in the principles of Black Love. I draw from the following tenets of the Black Love framework; STEM-related onto-epistemologies (tenet 1) and critical relationality focused on integration of youth voice and interest (tenet 2). Specifically, I pull on four subtenets that include high expectations of youth's STEM expertise and ability to do rigorous STEM now (tenet 1), validating youth's ideas, so youth see themselves as a doer of STEM (tenet 1), active noticing (tenet 1), and critical

community building through humanizing youth (tenet 2). Figure 4.1 represents the theoretical framework used for this chapter.

Figure 4.1: Theoretical Framework Undergirded in Black Love



The research questions are supported by the two case studies that explore how critical reflection, political action, and politicized trust to lead to critical agency. RQ1 looks at how learning opportunities were co-created while Donovan and Jabria critically reflected and took political action. Critical reflection is where Donovan and Jabria dealt with tensions in coding with scratch. This was supported by active noticing which included just-in-time teaching (Calabrese Barton & Tan, 2018) and culturally “STEMulating” pedagogical practices. Political action is where they had their pivotal interaction with me. I had high expectations of youth’s STEM expertise and saw them as capable of doing rigorous STEM. RQ2 examines the role of politicized trust in the development of critical agency. Through critical reflection and political action, Donovan, Jabria, and I were simultaneously developing politicized trust. By acknowledging their feelings, about STEM and myself, Donovan and Jabria were humanized

which led to us building a critical community with each other. Together through critical reflection, political action, and politicized trust it lead Donovan and Jabria to develop critical agency in their coding. To develop that critical agency it meant validating youth's ideas so they saw themselves as doers of STEM.

Methods

The methodology employed for this research study is participatory design research (PDR). PDR is a type of design-based research that addresses and works at reducing power dynamics by re-mediating who has power within a setting by dismantling and disrupting traditional power hierarchies actively involving the community in the design process (Bang & Vossoughi, 2016; Vakil et al., 2016; Zavala, 2016). Using PDR I present two case studies about two Black boys, Donovan and Jabria, and their journey in coding with scratch. Both boys were in the STEM program at the same time and went through similar experiences. While they went through similar experiences the reasoning undergirding those experiences were different.

Context

The Green Club is a STEM program for sixth and seventh grade youth that was established in 2010. I began working with Green Club in September of 2018 and have worked with them for about 3.5 years. The data presented in this article derives from field notes over the course of one year (September 2018 - May 2019). During the first year (2019-2020) of the Green Club, there were about 15 consistent participants. Programming took place weekly on Tuesdays from 4:15pm - 5:30pm. Once a month programming would be held at the UNCG Self-Design Studio. The UNCG Self-Design Studio is a university-based makerspace where youth have

access to a larger array of tools such as 3D printer, laser cutter, and materials to create structures with. They also usually have about three adult educators to help youth with their projects.

Figure 4.2: Coding Tools Used By Youth



Introduction to Case Study Youth 1: Donovan

Donovan is now a 14-year-old (age 11 during time of study), Black boy in ninth grade at a public high school. He has participated in the STEM program for about 2 years and is currently participating in the Teen STEM Club. Unfortunately at the beginning of the Covid-19 pandemic Donovan was one of the youth who was unable to attend BGC for about six months. Because of my conversations about Donovan with BGC staff they were aware that I was fond of him and alerted me that he would be returning. When he returned to BGC he was unable to attend STEM programming due to the restrictions on how many youth could be grouped together and becoming acclimated to participating in-person at BGC again. Although he was not in STEM programming from 2020-2021, he did stop by programming one day just to speak with me and let me know that he was back at BGC.

Donovan is very soft-spoken and usually keeps to himself. He loves sports, especially basketball and football, and likes to keep up with the latest stats and information on his favorite teams and players. Donovan is also on the BGC teens basketball team. He also has an interest in

“donk” cars which are older model Chevrolet’s that have tall rims and wheels, that have been redesigned and upgraded (Figure 4.3). Donovan loved to incorporate his interests into his coding. Donovan has a younger brother Keyshawn, age 13, who also participates in STEM programming with him. He also has a strong interest in working with technology and learning how to use various tools. Donovan is hesitant to engage in STEM activities when he is unsure of what he is doing. To fill the time, he would quietly do other things such as use google to search for donk cars or information/updates on his favorite team/players.

Figure 4.3: Donk Car



<https://www.youtube.com/watch?v=fe3rXKdVGY>

Introduction to Case Study Youth 2: Jabria

Jabria is now a 15-year-old (age 12 during time of study) Black boy in tenth grade at a public high school. He has participated in the STEM program for about 2 years as well. Just like Donovan, his participation at BGC was disrupted during the Covid-19 pandemic. Jabria did continue to come to BGC throughout the pandemic but because of the restrictions of how youth could be grouped he was not able to participate in consistent programming. Due to the number of youth in the Teen program and youth not being permitted in groups of larger than 10, Jabria received programming once every 3 weeks.

When I began the Teen STEM program in September of 2019 Jabria was unable to “officially” be in the STEM program due to sports. Jabria is very talented in sports and plays all year participating in football, basketball, and track. Since practices are usually held everyday after school, he was unable to attend STEM consistently. However, on the days that practice was cancelled he would always join me for STEM. Jabria is very outspoken and ready to share what is on his mind. He is also a jokester and likes to make jokes and do little pranks to keep others entertained. Jabria loves a challenging task and pushing the boundaries of what he can do. He is motivated to figure out complex puzzles and think about how things worked. However, he can easily get bored and disengage if he does not feel challenged by his work. Jabria is interested in musical beats and likes to incorporate music and sounds into his coding.

I chose to focus on Donovan and Jabria because of all the youth in Green Club that year (2018-2019), I spent the most time working with them through their coding. Donovan and Jabria both had to navigate what it meant for them to develop an “I can code” identity. While they both were able to develop this identity near the end of programming (May 2019), the ways in which they navigated developing these identities varied.

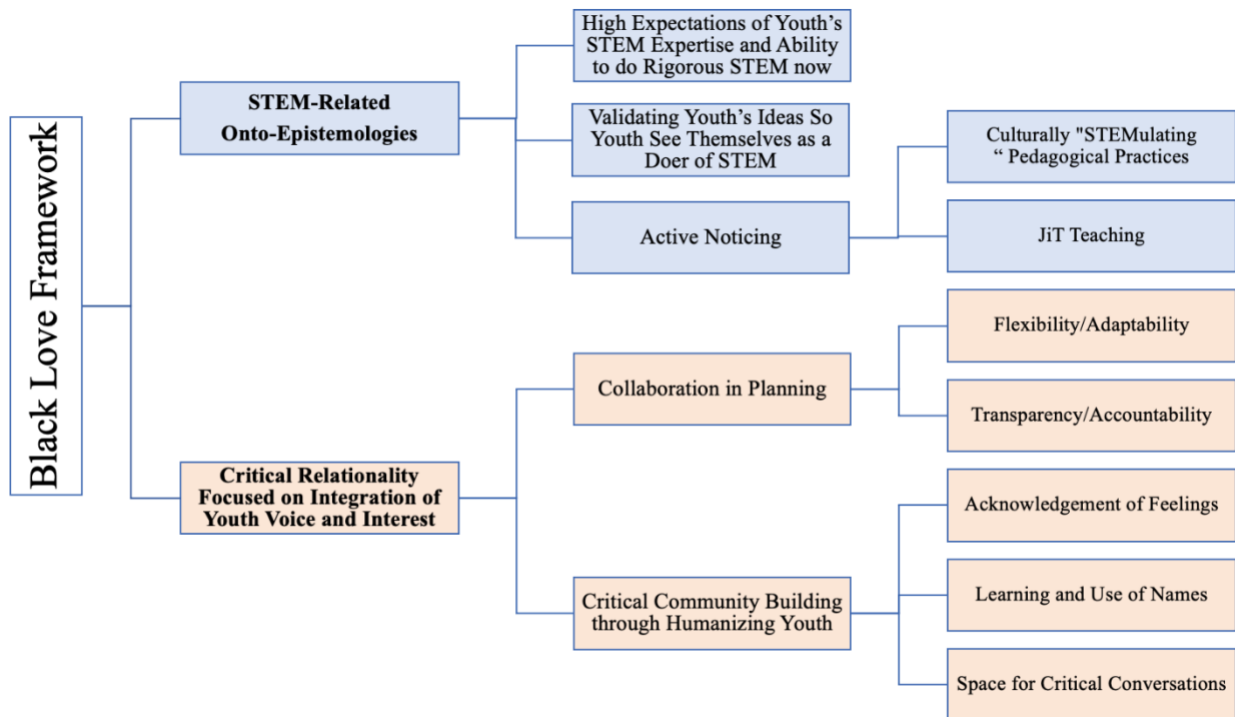
Data Sources

Data sources included fieldnotes; artifacts, such as youth work; group interviews; and video recordings and vlogs. Fieldnotes were taken after programming sessions. Artifacts included projects made by youth, as well as scaffolding resources to aid in the development of projects. Group interviews were conducted at the end of programming (May 2019) to reflect on programming throughout the year. Video recordings were taken over the span of the project development while periodically vlogs (video logs) were recorded at the end of programming for the day to reflect on the STEM activity sessions.

Data Analysis

Data were analyzed using grounded theory (Glaser, 1992) where youth were supported by me through the tenets of Black Love. First all fieldnote snippets that were related to either Donovan or Jabria were pulled. These snippets were coded using the Black Love coding tree (Figure 4.4). No distinctions were made between main tenets and subtenets, however if a subtenet was identified the adjacent parent codes were automatically included as well. For example, if JiT teaching was coded then active noticing and STEM-related onto-epistemology were automatically included. I looked across the codes to see which codes were frequently used. During the coding process, key moments surfaced that were crucial in the youth’s coding identity development. I identified these moments as examples of “I’m not giving up on you”.

Figure 4.4: Black Love Coding Tree



As a second layer of analysis to dig deeper, I used Cultural-Historical Activity Theory (CHAT) to analyze these “I’m not giving up on you” moments, specifically paying attention to the activity, community, division of labor and the outcome (Table 4.1). Outcomes are the different stabilizing, destabilizing, and restabilizing identities-in-practice youth took on such as, I don’t want to or I am unsure. Division of labor is the pre-interaction and post-interactions of when I became involved and how that affected the current activity. Community identified the people that were directly involved with Donovan and Jabria during the STEM activity. Lastly the activity refers to the STEM-related activity that they were doing at that moment.

Table 4.1: CHAT Analysis Example

Field Note Snippet	Activity	Community	Division of Labor	Outcome
As we were working, I noticed that Donovan was not as engaged as the other youth. Donovan has consistently decreased his interest in the program. I’m not sure if he doesn’t understand what is going on or he is actually uninterested. It’s very sporadic in that some things interest him and some don’t. I think it’s more of when he doesn’t understand he doesn’t want to do the work.	Scratch - played pong game, went through pong code, let youth hack/remix the code	Donovan	Donovan played the pong game. Together (whole group) we went through the code. Donovan did not hack/remix the code.	"I am unsure " mentality, restabilized.

To further examine these moments of “I’m not giving up on you”, I wrote an analytic memo. The analytic memo included pedagogical practices, an interpretation, and a description of the nature of the space in that moment (Table 4.2). The pedagogical practices named the actions taken to support youth in the moment. The interpretation including drawing on what had previously happened during programming to contribute to these moments as well as what I

perceived youth to need in the moment. The nature of the space consisted of two questions, 1) what he do when space was given and 2) what tools (both human/resources) were given. This memo was used to examine how both youth were navigating their coding identities and how they were utilizing all of the tools and funds of knowledge they had access to. After this analysis I noticed that the key moments for Donovan and Jabria correlated in phases. For this reason in the findings, I present their key moments in three phases.

Table 4.2: Analytic Memo Example

I'm Not Giving Up On You	Interpretation	The Nature of the "Space"
And watching Donovan I was seeing that he was participating up until the point that he had to code and change things for himself. Seeing him engaged in the first two activities let me know that she is interested in playing the games but when he has to actually code or change the game then he disengaged. This is also the point where I start to notice that when he doesn't understand he doesn't want to do it. because if he matched his involvement with the tasks that we are doing you can see where she does it and where he doesn't.	Third time, I notice that Donovan is engaged when we are playing the game and he continues his attention when we explain the game. Where he disengages is when we ask them to remix/hack the game.	<p>What did he do when given space?</p> <p>Donovan would play scratch games and followed along with us as we went through the code. When he had to remix/hack his game he chose to continue playing scratch games.</p> <p>What tools were given (human/resources)?</p> <p>Human: Facilitators, youth (both STEM participants and youth at club), BGC Staff</p> <p>Resources: Laptops, scratch access</p>

Findings

The findings are presented as two case studies focused on three phases (tensions to coding with scratch, pivotal interaction with educator, and development of critical agency) that address the research questions. The first research question addresses how learning opportunities

were co-created through critical reflection and political action in coding their games. The two phases that answer RQ1 focuses on how Donovan and Jabria navigated their tensions in coding with scratch (phase one) and their pivotal interaction with me (phase two). As they navigated these tensions, I supported youth in their critical reflection by actively noticing when they need JiT teaching and identifying culturally “STEMulating” pedagogical practices. Political action is supported by high expectation of youth’s STEM expertise and ability to do rigorous STEM now. The second research question focuses on how the establishment of politicized trust with myself supported youth to develop their critical agency. Phase three addresses RQ2 by looking at how their trajectory over time led them to develop that critical agency in their coding. To develop that critical agency I supported youth by validating youth’s ideas so they saw themselves as a doer of STEM. As youth and I developed politicized trust this was supported through the humanizing of youth through acknowledgement of feelings in critical community building.

At this point I would like to address two clarifying factors as you read these case studies. First it is important to state that these phases are listed in the order that Donovan and Jabria experienced them, but it does not equate to this being a linear process. For example, their tensions with scratch would continue after their development of critical agency but they became better prepared to navigate those tensions. Second, I share that politicized trust continuously developed in the background throughout each of these phases. Each phase is presented in two parts first addressing Donovan’s experience and then Jabria’s experience.

Tensions to Coding with Scratch

Both Donovan and Jabria began working with scratch in September 2018. One of their first projects was to conduct a community ethnography to learn what staff and youth liked about BGC. Community ethnography supported youth becoming researchers by investigating their

community specifically to learn more about how the people (other BGC youth and staff) felt about BGC. The responses gathered were then used to design their story about BGC. Donovan and Jabria worked in pairs with other youth peers in the Green Club to create their stories. At this time Donovan and Jabria were engaged with coding on scratch. Over the next few sessions, we began to dig deeper into Scratch by asking youth to expand on their coding. We (myself and the other facilitators) wanted youth to use more complex coding combinations to experience all that scratch had to offer (Table 4.3). As we shifted into the more complex coding, this is where I noticed Donovan and Jabria beginning to disengage in their scratch coding. In November youth were also introduced to another form of coding, color coding, that was used with ozobots. Ozobots are tiny robots that are coded using color coding. Color coding is the use of four-color combinations (red, blue, green, and black) that would lead the ozobot to do different moves such as turn left, zig zag, or spin. In February youth were introduced to another tool called MaKey MaKey, which is a kit that allows users to turn everyday objects into controllers. This kit was introduced to supplement scratch. Below I describe how Jabria and Donovan used all of these tools to engage and disengage in coding with Scratch.

Table 4.3: Scratch Coding Functions

Code Function and Color	Description
Motion (Blue)	Controls sprite's movements
Looks (Purple)	Controls sprite's appearance/costume
Sound (Pink)	Controls sprite's sounds/music
Events (Yellow)	Creates a trigger for sprite's actions
Control (Light Orange)	Used to control/manipulate coding
Sensing (Teal)	Used to detect other sprite's or backgrounds
Operators (Greens)	Compares variables and values
Variables (Dark Orange)	Used to store values
My Blocks (Red)	Used to create new blocks for sprite's

Case Study Youth 1: Donovan

Donovan first worked with Scratch during the community ethnography where they interviewed staff and youth about what they liked about BGC. Donovan partnered with Tremaine, another participant in Green Club, in creating their story about what youth liked about BGC. During the interview Donovan learned that youth like BGC a lot because of the gym so they could play sports. This led them to create a scratch about youth playing basketball. The scratch they created involved five sprites (characters) that included two Black boys, a Black girl, a monkey, and a puppy (Figure 4.5). The story started with a chat bubble beside the puppy that said hello. They recorded their own voices you hear Donovan says, “What’s up Kamarri” and Tremaine says, “Come play basketball with us”. In the background, they added the sound of a basketball bouncing. Donovan was very happy with his work, and with Tremaine was able to learn and try out different aspects of Scratch.

Figure 4.5: Donovan's Community Ethnography Based Scratch



As youth completed this project we began to shift them into doing more complex coding with scratch. We introduced tutorials and worksheets from the scratch curriculum with explanations. The tutorials and worksheets focused on how to make a character move across the screen, change backgrounds, play sounds, and create a game. However, Donovan would always

try to code without following the tutorials or worksheet that were provided. This led to issues in his coding because they would not run successfully. I would notice that he was having an issue and it would prompt me to go to him and ask what he needed help with. Donovan would not raise his hand for help but instead I would see him at the laptop not coding. To assess what he needed help with I would always ask where he was at in the tutorial/worksheet, and he would shake his head no. I would remind him that the tutorial is there to help him so he should follow it. He would then follow for a few steps but when something did not work, he would stop again. From November 2018 to February 2019, I noticed that there was a tension with scratch because whenever we did an activity that involved scratch Donovan would open the website but also open another tab to use google image and search for his favorite football/basketball players and donk cars. When I would walk over to him to ask if he needed help, he would switch tabs to scratch and continue to sit silently. I would try to ask specific coding questions but Donovan would not really describe what he was having an issue with. It is important to note that while Donovan was uncertain about how to engage with Scratch, he would always open the program and attempt to code at least once. However, after a few attempts he would stop coding and do other things of interest.

Donovan initially started off very engaged with scratch but soon disengaged when we shifted into more complex coding. While he was always willing to try to code, he would always stop and switch to other tasks. The fact that Donovan would always attempt to code was intriguing to me because it showed that he was not completely against using scratch there was just something that was not connecting. I also paid attention to what he would do on the laptop when he was not coding because it showed me what his interests were. I made it a point to always ask how I could help because although I had observed that he would probably not do the

scratch activities I wanted him to know that I was still ready to help him when he needed it. I also did not want to hover and constantly probe because I did not have established trust. I had to know when to step up and step back, so I would address him once and then leave him alone with the tools. Leaving him with the tools was a way for him to know that he still had access to code if he wanted to but if he wanted to continue googling images that was okay as well.

Case Study Youth 2: Jabria

When Jabria first started working with scratch, he was immediately intrigued by the sound clips. Scratch had a selection of pre-loaded sound clips that could be manipulated. Manipulations included speeding sounds up, slowing them down, making them louder or softer, and fading them in and out. Jabria liked working with the sounds and at the time was more engaged with coding because he could add in the sound elements. When we transitioned youth into using more complex coding, Jabria began to disengage in coding with scratch. While he did not have an issue with the action of coding itself, his tension was that he was becoming bored with coding. I asked him what was wrong and he replied, “we aren’t doing fun stuff like we used to do and I don’t want to be here”. In response to Jabria’s statement, I encouraged him to code a story that he was interested in, rather than the community ethnography-based scratch that others were working on. This helped and Jabria got started and every once in a while, I would glance over at him and he would smile. Jabria’s smiles were a silent agreement to me that he was working. His disengagement looked like verbally stating to me that he did not want to do STEM for that day and choosing not to use scratch. If I sat beside him and encouraged him to code, he would do it but very unwillingly.

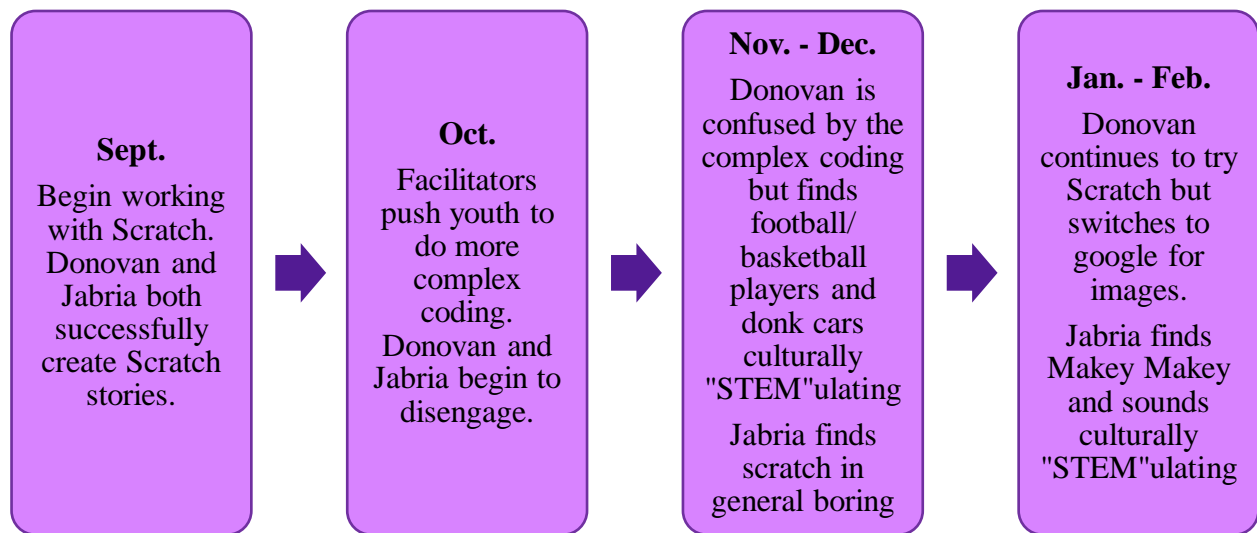
Later we introduced MaKey MaKey which is a kit that turns everyday objects into controllers and we used it to supplement scratch. The kit was very intriguing to Jabria because it was challenging to him. When Jabria first used MaKey MaKey he partnered with his close friend Tavior and they worked extremely well together. Jabria was engaged the entire time. They were able to successfully complete and test the controller. The controller was made of a foam pad, metal bar, aluminum foil, alligator clips, and a metal button (Figure 4.6). After creating the first controller they decided to make another controller and Jabria took initiative by asking one of the makerspace assistants how to connect the controller so they could use them at the same time. The following session youth continued working with MaKey MaKey, we asked them to recreate what they had learned the previous week and Jabria and Tavior took lead with this task. After they explained in detail how the MaKey MaKey worked they continued iterating on their controllers. Jabria ran into an issue where he forgot which wires connected to incorporate the second controller. He sought my help with the issue and we worked through it. Once we figured it out he pulled out a piece of paper and drew a diagram to remember how everything connected.

Figure 4.6: Jabria and Tavior's MaKey MaKey Controller



Jabria started off interested in coding with scratch because of the sound portion with the codes. While he had moments of needing clarification in how to move forward he generally understood how to successfully code. When he did not want to code I would always sit beside him to discuss why he did not want to engage and he would always verbally express that it was not fun to him. This action was to further emphasize that I was there for whatever he may need support wise. Noticing that fun was key I would try to find ways that it could be fun by Jabria's standards, for example encouraging him to code a story that was of interest of him. Once he would get started I would leave him to his work and periodically glance at him as a check-in to make sure everything was ok. Jabria would smile and nod in response to say that he was okay and was continuing to code.

Figure 4.7: Timeline of Tensions to Coding with Scratch



After observing and talking with Donovan and Jabria over the five month period I began to notice what their specific tensions were with scratch (Figure 4.7.). Jabria and Donovan both had tensions around using scratch but for different reasons. With Donovan his tension with scratch was grounded in not fully understanding how to code and for Jabria his tension was being

bored and not seeing it as challenging. Jabria expressed that we were not doing fun stuff anymore which made scratch boring to him. From his statement he is naming why he is not interested in coding, he does not see it as fun. This is an immediate trigger, that I must figure out what makes coding fun for Jabria. From our interactions I know that he likes to be challenged in his work. For example when we first introduced scratch, Jabria was immediately interested in the sounds prompting me to have a JiT teaching moment to show him how to integrate that into his coding. With Donovan he is less verbal than Jabria so I had to rely heavily on my noticing of his actions with scratch. Donovan initially did well with coding when he worked with Tremaine but soon struggled when having to do more solo work. I noticed that he did not have an understanding of how to code, but more importantly struggled with how to ask for help. However even in his moments of uncertainty he still puts forth the effort to at least try to code. This small action is a signal that he is willing but just unsure.

What I also notice are what I refer to as “culturally STEMulating factors”. Culturally STEMulating means that it is of interest to youth as it relates to STEM. For Jabria I noticed that his interest would peak with different tools that we were introducing. For example, with the scratch program itself Jabria was not particularly motivated in the coding alone, but he was STEMulated to code with scratch because of the sound clips and the addition of MaKey MaKey. With Donovan he is interested in basketball, football, and “donk” cars. At this moment Donovan had not linked it to STEM but as he moved into the second phase I see how these interests play a key role in changing their outlook on how they engage in coding.

Pivotal Interaction with Educator

My second noticing was that Jabria and Donovan both had a pivotal moment with me that changed how they moved forward with scratch. I name these moments as pivotal because the interaction key in shifting their perceptions of how they saw themselves moving forward with scratch. In March 2019 youth began working on their games to present for Science Everywhere. Science Everywhere is a festival where the local community and schools are invited to learn and explore varying aspects of science, and the Green Club was scheduled to present and teach about either ozobots or scratch. Youth had the option of creating one of three games with Scratch (a maze, scrolling, or pong game) or they could create a custom coded track with the ozobots. Below I share how my noticing of their culturally STEMulating interests play a key role in the pivotal interaction as Donovan and Jabria develop and design their games.

Case Study Youth 1: Donovan

Donovan chose to create a pong game. The pong game consist of continuously hitting a ball with a paddle that only moves left to right, and when the paddle misses the ball the game ends. Though Donovan chose to create a pong game he became frustrated that he could not correctly code his game and the following session said he wanted to create an ozobot track instead. Donovan started designing a track for the ozobot that used his name, but could not figure out how to connect all the letters so that the ozobot would flow from one letter to the next. We had a scheduled session at the UNCG Self-Design Studio and Donovan once again sat in silence, but he was not working with the ozobots or Scratch. I pulled Donovan outside to discuss one-on-one how he could to move forward with coding. Below is our conversation.

Ti'Era: I noticed you haven't started, so what's going on?

Donovan: [looks at floor in silence]

Ti'Era: Well you know you still have the option to make a track or a game, whatever you decide?

Donovan: [looks at me, but still does not respond]

Ti'Era: I have a feeling you want to do scratch, and I promise to do whatever is needed to make sure you get it done, even if I need to sit beside you each week, I'll do it. I won't let you mess up.

Donovan: [looks up at me and nods head in agreeance]

Ti'Era: Now, do you want to work on a scratch or make a track?

Donovan: I want to make a game

We move from hallway to makerspace to begin work

Ti'Era: So you want to make a pong game right?

Donovan: Yes

Ti'Era: Ok so first we need to plan, I need to know what kind of background, ball, and paddle you want.

Donovan: [sits silently, unsure of what to choose]

Ti'Era: I know you like donk cars, what if you add that to your game?

Donovan: I can do that?

Ti'Era: Of course, its your game.

Donovan: [nods head in agreeance] I want the car to be the background.

Ti'Era: Then what do you want for your ball and paddle. [I open scratch so he can scroll through the options.]

Donovan: I want the basketball and the green paddle.

After Donovan shared what he wanted to be included in his game we went through the coding template worksheet for the pong game. Together we reviewed what the codes meant and began to add them to his pong game. Donovan worked on his game the entire time and I sat right beside him (Figure 4.8). Donovan asks questions when he is unsure of what a code means or if something does not work as he intended. Over the next few weeks Donovan completed his game and shared it at Science Everywhere. The goal of the game was to keep the basketball from getting past the paddle. If the basketball touched the paddle or the edge it would continue to move, but if it touched the bottom black area then the game would end. There were about 25 codes used that included motion, event, control, sensing and operators. Donovan took joy in telling people that he taught his game to over 80 people (adults and youth) at Science Everywhere and is ready to code his next game.

Figure 4.8: Donovan's Scratch Game for Science Everywhere



When Donovan was choosing which game he wanted to create for Science Everywhere I was shocked that he chose scratch over ozobots given all the tensions he had with scratch. However this was also a signal to me that he really did want create a pong game even if it meant using scratch. The tension continued with scratch when he struggled to correctly code his pong

game, prompting Donovan to switch to working with ozobots. At the UNCG Self-Design Studio it seemed that Donovan was at a crossroads, unsure of how he wanted to move forward. Because I had been observing all of his actions I felt the need to intervene and explicitly let him know that he had my full support in whatever form he needed so he could move forward. During this exchange Donovan begins to verbally state his vision for his game and begin to ask questions when he does not understand something. I follow my words with action and sit beside him for the rest of programming. When we return to our sessions at BGC I enter the room and go to Donovan first so he knows that I am there to support him as my first priority.

Case Study Youth 2: Jabria

Jabria decided to create a maze game. The maze game had a small sprite that would navigate through a course to find the finish point. However, if the participant were to hit a boundary while navigating through the course the game would end and the sprite would return to the beginning. As the laptops were passed out to get started Jabria was not motivated to complete the maze. He made comments that he wanted to leave and there was a BGC staff present on this today. The staff member radioed Jabria's staff leader to say that he wanted to return and to alert the leader that he would be on his way. However, the moment the staff made the call Jabria immediately looked remorseful and did not leave. The following week when Jabria came to programming, I spoke with him outside before he entered the room to get started. Below is an excerpt of our conversation.

Ti'Era: So last week, I understand you weren't feeling making a game, but let me tell you why you should make one. Do you remember when you and Tavior made those controllers in the makerspace (UNCG Self-Design Studio)?

Jabria: [smirks] Yeah

Ti'Era: Do you realize that you made a way more complicated controller and got further with it than everybody else?

Jabria: [smiles] Yes

Ti'Era: Well I want you to make a game so you can make a controller to go with it. And honestly your too good with your coding for me to just sit here and not let you make a game.

Jabria: [laughs]

Ti'Era: I'm being serious, you're good at this. Last week is over so here is what we will do today. I want you have a game done by end of the day (programming). I will be right here by your side to make sure you have all the support you need. I know it seems short but I also know you can finish it

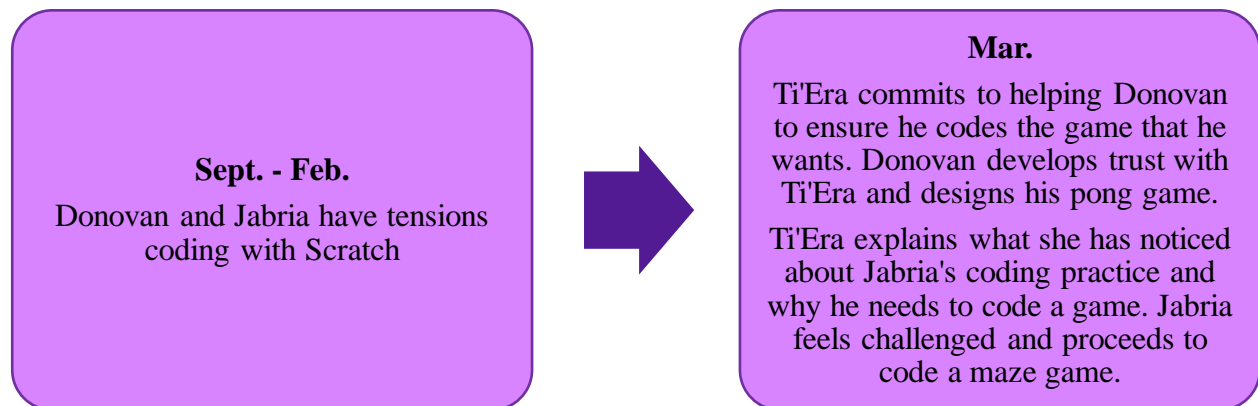
Jabria: Okay

Ti'Era: [smiling] can we get this done today?

Jabria: [nods head and gives Ti'Era a fist bump in agreeance]

After having the talk with Jabria he came in and got started. He asked if it was okay to have two laptops so he could code and play a basketball game when needed (as a break for him). I agreed and said it was fine as long as he was coding, so he put his headphones in and alternated between the laptops. As Jabria planned out what he wanted his maze to look like he became confused about which sprites went with certain codes so he asked me to clarify for him. Over the next couple of weeks Jabria finishes his game which he calls the "impossible game" because no one can beat it (Figure 4.9). He takes joy in watching everyone struggle to win his game.

Figure 4.10: Timeline – Pivotal Interaction



For Donovan and Jabria I had to take different approaches to support them in coding with scratch (figure 4.10 shows their progression on a timeline). Because Donovan was very unsure of his coding abilities, he needed to know that he would have individualized one-on-one support from myself as he progressed in creating his pong game. When we go into our discussion I see Donovan begin to develop trust with me as he starts to verbalize what he wants to see in his game and asking about codes that he is uncertain about. From the previous section Donovan's actions when he did not want to code was to google image search donk cars, so when I suggested he incorporate this into his game he asked if he could do that, almost to ask if it was allowed. I assured him he could because this was his game. By validating his idea he became more verbal in asking for help and designing the game how he wanted.

When I told Jabria that he was too good for me to not let him code was an example of me holding high expectations of his STEM expertise and knowing he had the ability to do rigorous STEM now. With Jabria he needed an approach that felt like a challenge. After the incident from the previous week I wanted to ensure that Jabria knew I wanted him to be a part of programming and I saw the potential he had to offer. For the other youth we had only asked them to make a

game but for Jabria I knew the MaKey MaKey controller was going to be key in getting him to code his game. Jabria always liked going above what was asked so when I acknowledged his abilities this made him happy. His only request in coding his game for the day was if he could switch between playing an online game and coding his game. I assured him this was fine because the focus was that he coded his own game. After Donovan, Jabria, and I have these pivotal moments they then shift into a final phase where they develop critical agency in their coding and shift their coding engagement.

Development of Critical Agency in Coding

After the pivotal moments with Jabria and Donovan, I noticed that their engagement with scratch significantly increased. During programming they now would work the entire time on their coding and I did not have to do as much to motivate them. Donovan and Jabria both finished their games and presented them at Science Everywhere in April 2019. After presenting at Science Everywhere Donovan and Jabria created games for the coding festival. The coding festival was an in-house event where all BGC youth had the opportunity to see what the Green Club had been working on and try out their games. Youth did another community ethnography where they asked BGC youth what they knew about coding and what video games they were interested in playing. From the responses gathered Donovan created two additional games and Jabria decided to update his game.

Case Study of Youth 1: Donovan

When Science Everywhere finished we had a debriefing session with youth to reflect on their experience. I asked youth general questions such as what went well and what did not go well, and how they felt about it. Donovan stated that “people did not understand what to do with my game. When it was over, I told them how to stop the game but they didn’t listen”, but overall

enjoyed the event and asked when we would do it again. I then shared about the coding festival that would take place in the following month. From the community ethnography for the coding festival, sports were a top theme for video games so he created a football-themed game. The purpose of Donovan's game was to throw a football back and forth between two football players on opposite sides of the screen. To do this Donovan had to download jpeg images of the athletes as sprites (characters) into scratch. I reminded him how to do this and then he began working on his own to format his characters the way he wanted. By formatting I meant that he wanted to adjust the sprites' specific locations and make them a specific size.

When he was ready to code Donovan asked for help and I noticed that he would second-guess himself, but he was on the right track with which codes to use. To support him I framed my help with questions. For example, Donovan wanted his game to move the football from the left side of the screen to right like a football pass. I asked him what type of codes he needed, and which color would those codes be. I asked these questions because the codes are separated by functions (i.e. motion, sound, event) and colors (motion codes are blue, sound is pink, and event is orange). This method helped a lot and once Donovan added all the codes and saw it worked he smiled and we exchanged a high-five. Donovan was one of the few youth who attended the coding festival and was able to explain to other BGC youth what coding was and how the game worked. After the coding festival we had another debrief for youth to share their thoughts about how it went. Donovan stated, *"It was good but I don't know why. They (participants) did good, great on my games. I liked that I had two games."* Donovan even went on to say that he liked scratch by itself (without the use of MaKey MaKey) and wanted to do more coding in the following year.

Over the course of eight months, Donovan's trajectory of his engagement with scratch had shifted significantly. Now Donovan would take the lead with his coding and advocate for himself when he needed help. Donovan saw how his interest could be embedded in his coding which motivated him to because he had more control with his games. I also see Donovan become more verbal about the supports he needs to move forward because he knows I am invested in his coding as much he is.

Case Study of Youth 2: Jabria

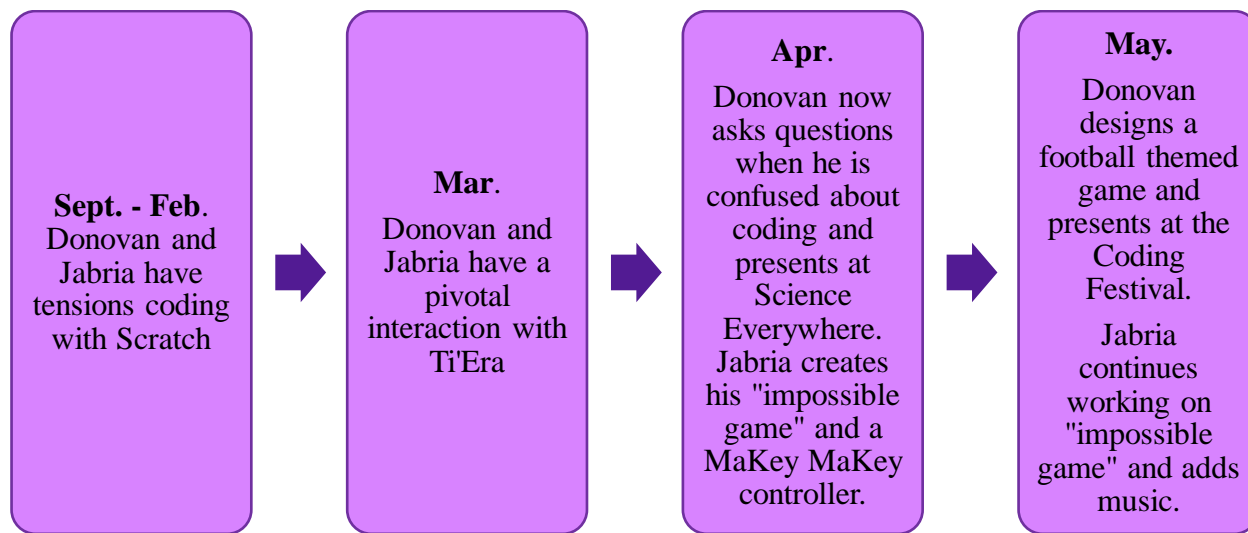
Jabria was not able to attend Science Everywhere but he was able to participate in the coding festival. When youth completed the community ethnography for the coding festival Jabria decided to stay with his original game created for Science Everywhere. Jabria referred to his game as impossible and unbeatable because he was the only person who knew the trick to it winning it. It made him laugh every time someone became frustrated because they could not beat his game. When youth completed the community ethnography with other BGC youth about the type of games they liked Jabria decided not to make a new game, he instead chose to add music to his maze game. He had been listening to the sound clips on scratch but did not find one he liked. I noticed that Jabria had been listening to a rap song on youtube so I suggested he use the song in his game. Jabria like this idea and asked how he could do it, so I showed him how to download the song and upload it to scratch as a sound clip so he could code it.

Right before the coding festival Jabria had brought in all of his equipment, the laptop and his MaKey MaKey and began to set up. Unfortunately, he was picked up early on this day and was not able to present his game himself, but Donovan and I volunteered to help BGC youth with all the scratch games. Jabria's game was very popular due to the music he added. Many of the participants at the coding festival were asking to play it

because they would hear the music and rushed to play it. His game was also very hard to beat which made it popular as well. BGC youth lined up to try and beat Jabria's "unbeatable game" and became more determined with each try. When we saw Jabria the following week we shared how popular his game was at coding festival and he immediately began smiling.

With Jabria's trajectory I see his scratch engagement shift from being bored with coding to finding ways to bring in what he identifies as "fun". Jabria expressed his agency when he decided not to create a new game based on but instead chose to add music to his original maze game that he deemed as "unbeatable". This shows that Jabria felt confident with what he had created, even with the declaration of naming his game so highly shows his critical agency in developing the game.

Figure 4.11: Timeline – Development of Critical Agency



As Donovan and Jabria near the end of programming for the year I see the full trajectory (figure 4.11) of how their interests have now been fully integrated into coding with scratch.

Jabria was very interested in sound clips and MaKey MaKey and his final project reflected both

of those pieces. Donovan was interested in football and donk cars and both of those elements were included in his games. Looking deeper into the interactions that led to the development of this critical agency, critical community building through humanization was key. Jabria and I had more interactions throughout the year which allowed us to develop a relationship earlier in the year. However, Donovan and I really developed our relationship after having our pivotal moment. At the beginning of the year Donovan was not very verbal with me but near the end I see him engaging in conversation with me about how to understand his coding which leads to him developing his critical agency. I notice how supporting Jabria and Donovan at their own rate afforded us the time to develop trust and build our critical community.

Discussion

From the findings I wanted to understand how Donovan and Jabria engaged in critical reflection, political action, and politicized trust to develop their critical agency. I also reflect on how my active noticing of culturally STEMulating factors supported youth by validating their ideas so they could see themselves as a doer of STEM. RQ1 focused on how learning opportunities were co-created through critical reflection and political action. During this process two key elements were identified, 1) continuous access to materials and 2) sustained engagement to reimagine possibilities.

Continuous Access to Materials

At the beginning of programming Donovan and Jabria had tensions with scratch that led them to disengage and choose not to code multiple times. However when they chose not to code no materials were taken away from them. Having continued access allowed me to actively notice what was culturally STEMulating for Donovan and Jabria. For example, when Donovan disengaged he would immediately turn to google to search for images that were of interest to

him, but he never lost his privilege to use the laptop. It is also important to note that his human resource (me) was not limited either. At the beginning when I would approach Donovan to see if he needed help with his coding, he was not verbal in expressing what he needed to move forward. I acknowledged his actions but continued to be available for Donovan when he was ready. Having access to the materials was critical for me because I could actively notice some of Donovan's personal interests that were later used to support his coding.

Jabria's continued access to the materials allowed him to freely explore all the coding options that scratch had to offer. For example when we first introduced scratch to youth, Jabria found the sound clips and began to manipulate them. Incorporating sounds was not a part of the initial activity but because Jabria found it interesting and by his final project he learned how to upload sounds that were not pre-loaded into scratch. Similar to Donovan it was also important for Jabria to have continuous access to human resources as well. Although he stated that he was bored with scratch I would suggest that Jabria incorporate elements that were not required in the coding activities to broaden his learning opportunities. Through my active noticing I am able to learn what Donovan and Jabria find culturally STEMulating and use that to keep them engaged in coding.

Sustained Engagement to Reimagine Possibilities

These case studies took place over the course of eight months. When I zoom in on that timeline for the first six out of the eight months Donovan and Jabria grappled with what it meant for them to code and their interactions with scratch during that time were mostly negative. They then have a pivotal moment that shifts how they see themselves coding with scratch and for the last two months they continued to develop their critical agency. When I zoom out and look at the timeline, the majority of Donovan and Jabria's interactions with scratch were filled with tension.

As the educator I had to reframe my lens to truly understand what their interactions meant. I asked myself, what do I actively notice them doing when they are disengaged. This was important because their moments of disengagement showed me their interests which became critical to their coding success. While they were not very motivated to code with scratch, they were motivated by their interests. I was able to use Donovan and Jabria's culturally STEMulating interests as a motivator to support their coding.

Donovan and Jabria were able to reimagine what the learning opportunities with coding looked like because they were culturally STEMulated and their ideas were validated thus leading them to see themselves as a doer of STEM. At the beginning of programing, I actively noticed Donovan being interested in donk cars and football and Jabria interested in sound clips and MaKey MaKey. I pause here to highlight that it was not enough to just be knowledgeable about their interests, but I needed to *act* on their interests. Their interests were the culturally STEMulating factors to motivate them to continue their engagement with scratch. As we neared the end of programming Donovan and Jabria came full circle as their interests were embedded in both of their games. They are then able to share and teach about their games at Science Everywhere and the coding festival. Teaching at these events opens the opportunity for Donovan and Jabria to share the possibilities with others about how coding can be reimaged.

RQ2 addresses how the establishment of politicized trust between Donovan, Jabria, and I impacted, in what ways, their development of critical agency. Politicized trust involves understanding each other, respecting one another, and being in solidarity with one another. I also share how my active noticing and continued high expectation of their STEM expertise and ability to do rigorous STEM now led to the development of critical community. From the findings, politicized trust was developed through two important elements, 1) understanding that all

disengagement is not equal and, 2) being explicit in communicating expectations followed by concrete action.

All Disengagement is Not Equal

The tensions experienced by Donovan and Jabria while learning to code with scratch, were often disengagement. While both boys disengaged it is important to look past the surface to understand their reasoning for not wanting to engage with scratch. Jabria was verbal in his reasoning for not engaging with scratch, he did not find it fun nor challenging. However with Donovan his reasoning was harder to identify because he would not verbally express what his tension was with scratch. Over a five month period I had to actively notice his actions when he chose not to code with scratch. I realized that Donovan did not understand how to code which was very different than Jabria's reasoning.

From these two cases I noticed that their reasons for disengagement were completely different. However the only way for me to know this was by understanding what those tensions meant for them and respecting those tensions. It is important to note these differences because it could have been misinterpreted as they were disinterested in coding and therefore disinterested in STEM. Jabria's coding skills could have been overlooked and not fostered and Donovan could have missed a learning opportunity that he really wanted to understand but did not know how to ask for help. Had Donovan and Jabria not been fostered in their coding I would have missed opportunities for other BGC youth to reimagine the possibilities in coding.

Be Explicit in Communicating Expectations and Follow with Concrete Action

During the pivotal interactions with Jabria and Donovan this was a critical moment to show that I would not give up on them. I wanted them to know that I saw their potential, because I had been actively noticing their coding abilities, and wanted to see them move forward in

coding. For example with Jabria I explicitly named his expertise with MaKey MaKey and acknowledged the work he and Tavior were able to accomplish with their controller. With Donovan I acknowledged that I saw his small but continuous efforts to code with scratch which led me to believe he wanted to create a game. In both examples I held high expectations of youth's coding expertise and their ability to do rigorous coding now. I explicitly named the actions that I had actively noticed them doing to validate why I held these high expectations.

However it was not enough to acknowledge their efforts, it was key to follow up with concrete action by being in solidarity with them. In both pivotal interactions I committed to spending more time with them to ensure that they moved forward with their coding. While I had been available to help throughout the year, I now focused more of my time with Jabria and Donovan. They became my top priority because I identified that they needed it. When they would enter for programming I would go to them first and ask what they needed for that day. Once they started their work I would be sure to stay closer to them so I could be available as soon as they needed me. This was very critical for Donovan because from September – February, he expressed reticence by not sharing what he was struggling with in coding.

In March when Donovan and I had our pivotal interaction this was the foundation of politicized trust. In recognizing the power differentials, I communicated the expectations to Donovan and followed with concrete action. After this interaction Donovan began to verbally express his questions and concerns about his coding. This was an example of politicized trust in action: Donovan trusted me to facilitate a new direction he was challenged to take at my suggestion, I trusted that Donovan would be able to follow through by developing the required coding skills with my support, given this new direction. Both of us are aware of our power differentials (I being the more powered one structurally, Donovan being the one with the power

to actually do the coding work) we collaborated through shared solidarity across these powered differentials. By prioritizing my attention towards Donovan and Jabria it provided an opportunity for us to develop a critical community through establishing politicized trust. By having this politicized trust relationship with Donovan and Jabria being explicit in communicating high expectations and following with concrete action had deeper meaning for them.

Tensions

From the discussion I see the importance of developing politicized trust between Donovan, Jabria, and myself. While they were able to develop learning opportunities that benefitted their coding, there were tensions that arose during that process. Two tensions I found myself navigating were the individualized help needed and time. Time was a tension for me because it felt that it was not utilized in the best way. By this I mean I did not have my pivotal moment with Donovan and Jabria until their sixth month of working with scratch. When I reflect on that moment, I question should we have had this moment sooner or did it come at the right time for them. If we did have this moment sooner would their trajectory still be the same or would they have further disengaged with coding? It leaves the question, how much time is the right amount for youth.

My second tension was the individualized help that was needed for Donovan and Jabria. Since Donovan dealt with uncertainty in his scratch abilities, he needed more consistently to ensure that he was coding his games correctly. For Jabria, at the beginning I needed to sit with him to make sure that he would code and by the end of programming I had to include different ways to challenge his scratch abilities. From the findings I see this was key for getting Donovan and Jabria to engage with coding but crafting that individualized approach for them meant less time with other youth in Green Club. It asks the question who may have been left out and how

that could have affected how they view coding. These tensions are important for educators to consider when working with youth in community-based programs.

Conclusion

The relationship co-created between Jabria, Donovan, and I has shown how critical the development of politicized trust is for youth's STEM pursuits. When Donovan and Jabria began programming could not envision the potential of their STEM abilities nor the possibilities of what they could create. This is where I served as a connector to support them through the process of seeing themselves as a person who can code. The path Donovan and Jabria took to see themselves as a coder looked different because it was undergirded with different tensions in working with scratch. Donovan navigated uncertainty while Jabria dealt with boredom. However when a new path to coding was introduced that was emergent of their culturally STEMulating interests I begin to see them shape new learning opportunities.

These reimagined learning opportunities provide a different outlook of what it means for Black boys to engage in coding. In the arc of Donovan and Jabria's trajectory I see that they had continuous access to materials and sustained engagement to reimagine. Green Club took place weekly which provided sustained opportunity to explore the possibilities in coding. Though each session was not always productive for youth because of their tensions with scratch their materials were never taken away. For me it was important to distinguish that not all disengagement is equal and to be explicit followed by action. During the pivotal interaction I explicitly named the positive efforts that I had observed in Donovan and Jabria to show that I was paying attention to them. But to explicitly name these actions meant that I needed to understand the reasons as to *why* they were disengaging with scratch.

Looking forward when I think about what this means for other youth I have to consider the tensions of navigating time given for youth to change their thoughts about STEM and how my role shifts as a result. My role shifts because it is dependent on what youth need in the moment. In the next chapter I take a more zoomed out approach that continues to look at the importance of critical relationality to support youth in STEM. Chapter 5 focuses on the co-created Teen STEM program and how youth and I are shaping what it means to design a Black educational space that centers anti-Blackness in STEM.

CHAPTER V: OF COURSE I SIGNED UP FOR STEM WITH YOU! INFORMAL
LEARNING ENVIRONMENTS AS A SOCIO-SPATIAL IMAGINARY

Introduction

Informal STEM learning environments (ISLE) have been found to be sites where historically marginalized youth can engage in STEM in meaningful ways. The opportunities for youth of color across ISLE include leveraging their funds of knowledge (Gonzalez et al., 1995) and community cultural wealth (Yosso, 2005) to engage in STEM through its multiple entry points (Calabrese Barton & Tan, 2010; Dawson, 2017). However, less is known about the intersection of ISLE that are housed within community-based educational spaces (CBES) (Baldrige, 2018). ISLE are designed in specific ways with norms specific to their respective environments. This chapter looks at how a STEM program was designed for Black teenage youth and the pedagogical practices that supported youth learning in that space. For these reasons I ask the following research questions:

1. What are the ways in which a community-based educational space serves as a Black Educational Space for youth to reimagine the possibilities of engaging in STEM-rich making?
2. What are the pedagogical moves for informal STEM educators to develop such learning environments that counters anti-Blackness?

Literature Review

To explain the design of the community-based informal STEM program I draw on literature from CBES and Black Educational Spaces (BES). I draw from this literature because

the STEM program is housed within a local Boys and Girls Club (BGC) that serves majority Black youth and the STEM program is undergirded in the principles of anti-Blackness.

Learning in CBES

Baldrige et al. (2017) names two ways that CBES can be seen as sites of resistance for minoritized youth --“First is the ability to disrupt traditional ways of learning by broadening what academic achievement looks like and secondly are the ideological shifts through pedagogical practices” (Baldrige, 2017, p. 392). CBES disrupts traditional ways of learning and in that they are flexible to address the needs of the youth. Educators enact these ideological shifts by supporting the development of youth’s critical consciousness. This means serving the whole child by addressing social, emotional, cultural, and political development (Baldrige et al., 2017).

Educators within CBES take on multi-faceted roles with youth (Baldrige, 2018). This includes simultaneously being an educator, counselor, mentor and friend, to youth participants. Another major factor of CBES for youth is their development of meaningful relationships with adult staff. As a part of these relationships, youth must be seen as valuable and important to adults (Baldrige et al., 2017). These relationships are bidirectional and support both adults and youth. The nature of such trusting relationships and the flexibility of CBES together work to reimagine youth’s resistance in educational spaces.

Black Educational Spaces

Jenkins (2021) defines anti-Blackness as “the socially constructed notion that Black people are non-human, inherently problematic, and disposable, structures the spatial arrangement and social imaginaries of every facet of American society” (p. 111). Socio-spatial imaginaries refer to how individuals come to understand, know, and exist in different spaces (Jenkins, 2021).

BES are seen as sites that are undergirded in anti-Blackness. When I look at traditional science learning environments, science tends to be taught without regard for other culturally diverse perspectives (Mensah & Jackson, 2018). Because the majority of science educators are white, science tends to be taught from a Eurocentric/westernized viewpoint. Youth of Color are then only exposed to these westernized notions of science that are not representative of non-western cultures (Mensah & Jackson, 2018). Due to the “whiteness as superiority” ideology, youth internalize science as an extended construct of whiteness. This leads to science learning environments becoming spaces of anti-Blackness, where Blackness is seen as a problem to be corrected rather than embracing the different perspectives that Blackness contributes to science (Dumas, 2016). Learning experiences are enhanced when youth are taught by educators who identify with them. However, the majority of the teacher workforce is made up of white women, which in turn means that science/STEM tends to be taught in very traditional ways.

BES for youth are spaces where Black people’s well-being are centered, often at the intersection between fugitivity and racial counterspaces. Fugitivity is the imagined space that fosters possibility and resistance, while racial counterspaces are seen as physical locations that center healing and community-building (Warren & Coles, 2020, p. 391). To further theorize the designs of BES, Warren and Coles (2020) pose the following questions: “How should such space(s) look and feel? What are the priorities guiding the structure and organization of such spaces by adults? What are the inevitable challenges of cultivating these spaces such that they intelligently and intentionally meet the needs of diverse black youth?” (p. 388-389). Three dimensions to provide solutions to these questions were named: self-determination, self-actualization, and self-efficacy. Self-determination is providing opportunities for Black youth to have autonomy in their decision-making about who they are and who they are becoming. Self-

actualization is acknowledging and embracing the diversity amongst Blackness while not further essentializing and stigmatizing Blackness. Lastly self-efficacy is when Black youth bring their whole authentic selves to the table and are not disassociated from any parts of their identities to achieve success.

Theoretical Framework

BES are identified as sites where self-efficacy, self-actualization, and self-determination happen at the intersection of racial counterspaces and fugitivity (Warren & Coles, 2020, figure 1, p. 391; figure 5.1). I expand on Warren and Coles (2020) theorization by exploring what BES looks like in an informal community-based STEM program that is undergirded in the principles of Black Love. Since BES are created and rooted in community, I expand on self-determination, self-actualization, and self-efficacy by problematizing the *self*. In problematizing the self, I highlight that for youth to achieve self-determination, self-actualization, and self-efficacy it must be done in conjunction with others. To frame this chapter, I focus on what these dimensions look like within the STEM space, in parallel with the principles of Black Love. I pull from these two tenets of the Black Love framework: STEM-related onto-epistemologies (tenet 1) and critical relationality focused on integration of youth voice and interest (tenet 2). Specifically, I pull on three subtenets that include validating youth's ideas, so youth see themselves as a doer of STEM (tenet 1), collaboration in planning (tenet 2) and critical community building through humanizing youth (tenet 2). Figure 5.2 represents the theoretical framework used for this chapter.

Figure 5.1: Conceptual Model of BES (Warren & Coles, 2020, p. 391)

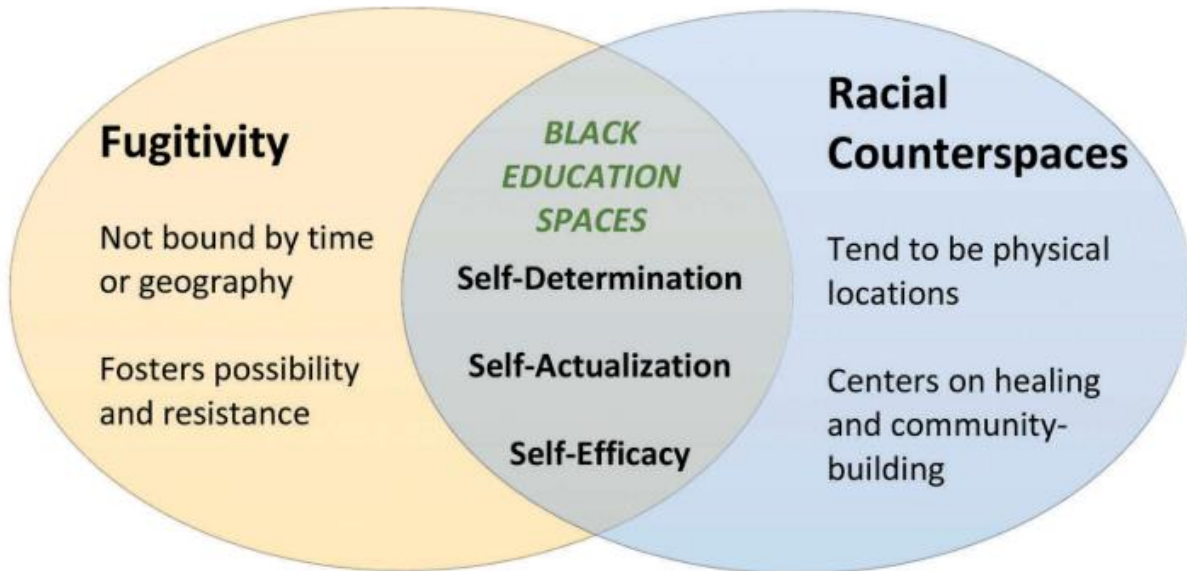
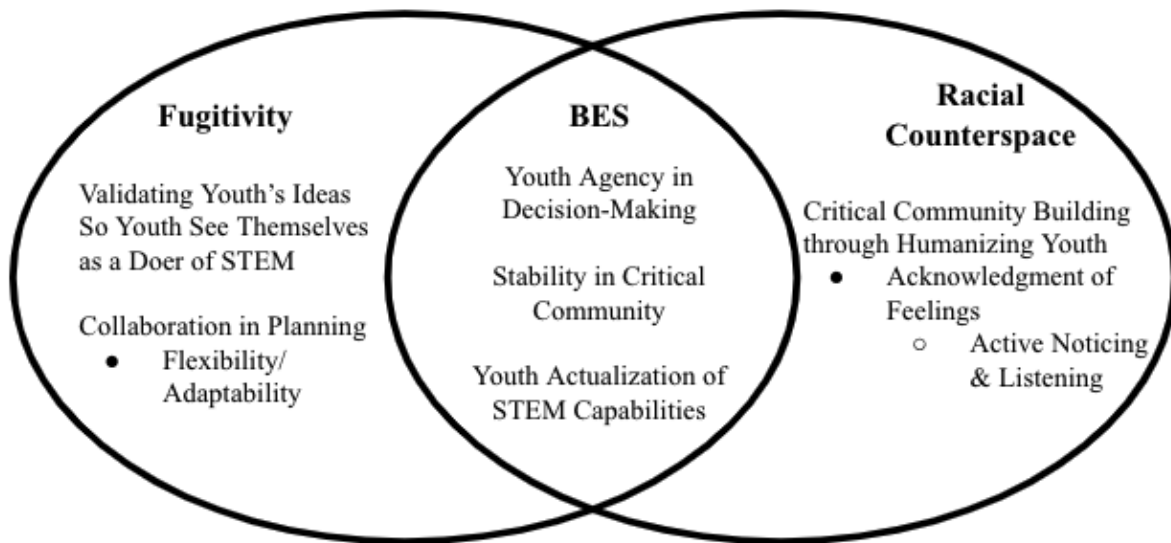


Figure 5.2: BES layered with Black Love



Methods

The methodology employed for this research study is participatory design research (PDR). PDR is a type of design-based research that addresses and works at reducing power

dynamics by re-mediating who has power within a setting by dismantling and disrupting traditional power hierarchies actively involving the community in the design process (Bang & Vossoughi, 2016; Vakil et al., 2016; Zavala, 2016). I use PDR to look at the co-constructed culture of the STEM learning environment of the Teen Center. PDR supports me to look at the following: design aspects, relationality between facilitators and youth, socio-spatial-material aspects, and learning trajectories of youth. Design aspects are comprised of the facilitation and pedagogical practices of the STEM program that includes rules and expectations. Critical relationality between facilitators and youth focuses on the relationships developed over time. Socio-spatial-material aspects include resources, both human and material, available to youth and how they interact with these resources. Lastly, the learning trajectories of youth will focus on how youth are developing their STEM identities and developing an understanding of STEM-related material. These components work together to create a learning environment where youth feel Black Love.

Context

The Teen STEM program is a new program that is a continuation of the already established Green Club. The Green Club is a STEM program for sixth and seventh grade youth that was established in 2013. However, when youth turn 13 they transition to the Teen Center, which houses youth between the ages of 13-18. Youth who previously participated in Green Club expressed that they wanted to continue their STEM programming, so the Teen STEM club was created. Teen STEM club began in September of 2019 and ended abruptly in March 2020 due to the Covid-19 pandemic. Programming resumed in September 2020 and has continued thus far. The data presented in this article takes place over the first two initial years of the STEM program (September 2019 - April 2021). During the first year (2019-2020) of the STEM club,

there were about 15 consistent participants. Due to the continuous changing circumstances surrounding youth physically going back to school from October - December 2020 there were about nine consistent participants, and from January 2021 - May 2021 there were five.

Data Sources

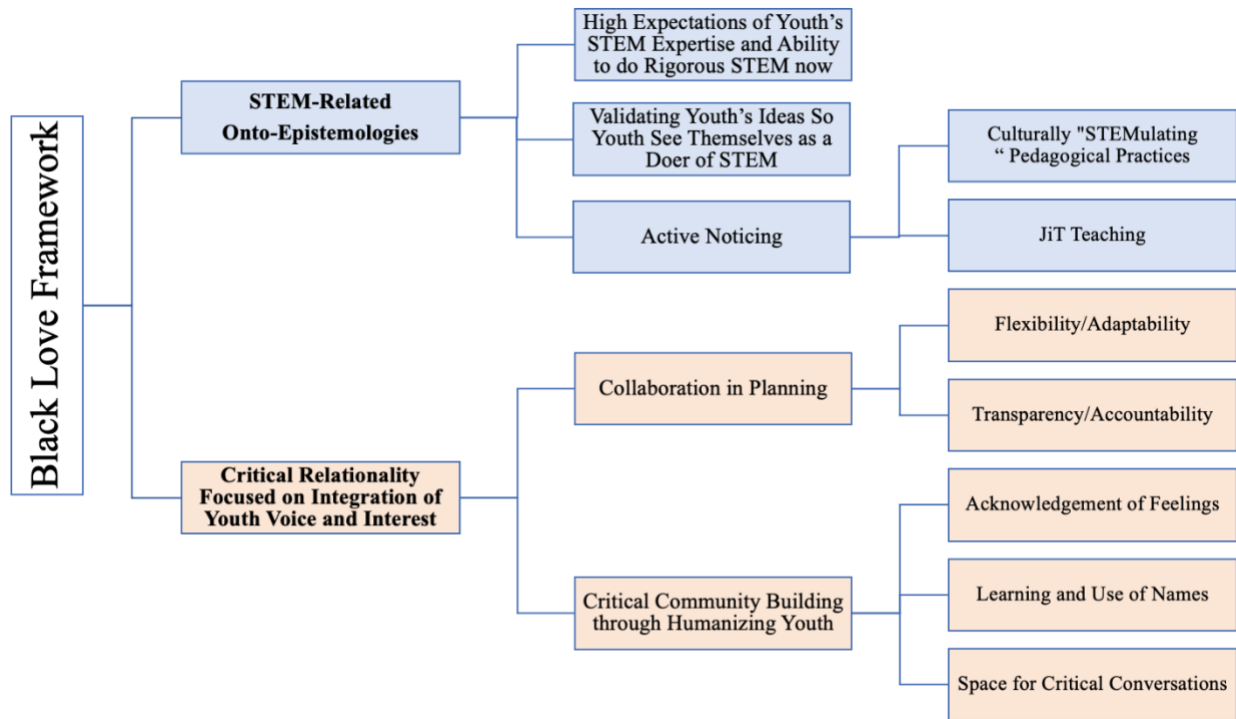
Data sources included fieldnotes; artifacts, such as youth work; group interviews; and video recordings and vlogs. Fieldnotes were taken after programming sessions. Artifacts included projects made by youth, as well as scaffolding resources to aid in the development of projects. Group interviews were conducted during summer sessions where youth reflected on my pedagogical practice. In order to reduce conflict of interest and to encourage the youth to speak freely, the interview was conducted by Dr. Edna Tan. The criteria used to determine who would participate in the group interview was if I had taught youth in-person for at least one academic year (September - May). Video recordings were taken over the span of the project development while periodically vlogs (video logs) were recorded.

Data Analysis

Data were analyzed using a grounded theory approach that sought to identify critical moments where youth were supported by me through the tenets of Black Love (Glaser, 1992). I read through all the fieldnotes to identify critical moments of Black Love. What surfaced were three critical moments that were key to establishing what the STEM club would look like. From these examples I conducted a second round where I pulled all the fieldnotes that related to these critical moments so that they could be coded using the Black Love coding tree (Figure 5.3). No distinctions were made between main tenets and subtenets, however if a subtenet was identified the adjacent parent codes were automatically included as well. For example, if

flexibility/adaptability was coded then collaboration in planning and critical relationality focused on integration of youth voice and interest were automatically included.

Figure 5.3: Black Love Coding Tree



During this round I coded the fieldnotes line by line looking for examples of Black Love. After this was completed, I looked across the codes to see which codes were being used frequently. This step allowed me to see which aspects of Black Love were being surfaced in the selected vignettes. The Black Love subtenets that were surfaced included; collaboration in planning (youth agency in decision making), critical community building through humanizing youth (stability in critical community), and validating youth’s ideas so youth see themselves as a doer of STEM (youth actualization of STEM capabilities).

After coding of the vignettes, I then looked at the interview data. Group interviews were conducted with youth during the summer of 2021. There only criteria for the group interview

was that youth had worked with me for at least one year in-person. I specify in-person because some youth worked with me virtually for one year and the dynamic of that experience was different. A protocol was created based on the Black Love framework to see how youth were interpreting the framework and what actions they felt I took to enact the framework. To be ethical, as these questions were about me, Dr. Tan conducted the group interviews. A total of ten youth, split into two groups of four and six were interviewed. Interviews were in-person lasted for about 20-25 minutes. When I listened to the interviews, I took note of responses and who they came from. I pulled responses that aligned with the three Black Love subtenets that were identified (collaboration in planning, critical community building, and validation of youth's ideas). These responses were then used to explain the importance of youth agency in decision making, stability in critical community, and youth actualization of STEM capabilities from youth's perspective.

Findings

The research questions are explored in three illustrative vignettes that focus on different possibilities of BES. The first research question looks at the ways in which a CBES serves as a BES to support youth in reimagining the possibilities of engaging in STEM-rich making. In the findings, I attempt to answer RQ 1 through vignettes one and three by looking at youth agency in decision-making and youth actualization of STEM capabilities. Youth agency in decision-making created opportunities for youth to decide how they want to move forward both personally and within the context of STEM. Youth actualization of STEM capabilities is supporting youth as they navigate their own STEM onto-epistemologies. The second research question explores the pedagogical moves for informal STEM educators to develop learning environments that counter anti-Blackness. Vignette two attends to RQ2, focusing on exploring

the notion of stability in critical community. Stability in critical community entailed creating a place (imagined or physical) where youth feel secure that the educator is committed to providing consistent programming where youth can show up as their whole unapologetic selves.

Each theme is presented with two parts; the first part unpacks youth responses in their group interviews about the STEM program that support STEM-rich making. Youth responses address RQ1 by looking at what youth have named as critical for their STEM learning experiences. Youth responses are presented in a table that shows the question asked and youth responses. The second part addresses RQ2 by sharing a vignette of how my pedagogical practices developed a learning environment that countered anti-Blackness. The pedagogical practices that expand on each theme are as follows; 1) youth agency in decision making shows the flexibility/adaptability in collaboration in planning, 2) stability in critical community shows critical community building through humanizing youth by acknowledging their feelings through active noticing and listening, and 3) youth actualization of STEM capabilities shows validating youth's ideas so youth see themselves as a doer of STEM.

Theme 1: Youth Agency in Decision Making

Youth Reimagining of Possibilities in STEM spaces through Agency in Decision Making

During the group interview youth discussed the importance of being afforded opportunities to have agency in decision making. Throughout programming youth were always encouraged to share their ideas whether it was about planning activities or choosing a specific project for themselves. Within the STEM club youth work towards final projects that they present and share at the end of the (academic) year. While the projects may have a common STEM theme such as coding, circuitry, or 3D printing youth are encouraged to make those projects their own. By this I mean that the projects are reflections of themselves and while we

may have 15 projects that all incorporate circuits, each project will be uniquely designed because it derives from youth’s visions of how they see the project. In Table 5.1 I share youth’s responses that show their agency in decision making and its importance.

Table 5.1: Interview Responses - Youth Agency in Decision Making

Question	Youth Responses
Did you feel that Ms. Ti’Era involved you throughout the process of creating your project? In what way?	<p>“She listens to us” – Trinity, 17</p> <p>“(listens to) our ideas and she gave her opinion” – Caleb, 15</p> <p>“Gave us all something to work on. I did the TVs. Entertainment. She is like a guide a personal counselor. Open to suggestions of all” – Sa’Ryah, 16</p>
How is Ms. Tee’s expectations different than the high expectations of school (science) teachers?	<p>“I think they are very different because with the teacher its forced, but Ms. Ti’Era has options where we can do something that we want” - Caleb, 15</p>
What do you think Ms. Ti’Era notices about you that is different from what your science teacher notices?	<p>“She makes the atmosphere feel comfortable enough for us to express ourselves, she makes it enjoyable to where we can do things that she needs us to do and also what we want to do” – Caleb, 15</p>
What does she do/say to make you say that she is a person who cares and want to engage with me?	<p>“She make it fun like where its to us. She listens to our suggestions” – Ashley, 16</p>
How does her input on your ideas come across as genuine and not fake?	<p>“Integrates your idea” – Ashley, 16</p>

From youth’s responses their agency in decision making looked like being listened to, open to suggestions, having options, expressing themselves, doing what they want to do, and integrating their ideas. Overall youth appreciated that within the STEM program they knew their ideas mattered and were important to how their projects and activities were developed. In two of

Caleb's responses we see a comparison of the atmosphere in his formal science classroom to the atmosphere of the STEM program. He shares that in the classroom it is different because they are forced to work, but in the STEM program the atmosphere is comfortable enough to express himself. When we look at the design of the STEM space one of the tenets in the Black Love framework is collaboration in planning through being flexible/adaptable. Because Caleb is involved in the process of designing his STEM learning experience, he feels more comfortable in sharing his ideas. While there is a "forced" STEM component that youth must adhere to in the STEM program, Caleb is okay with that because he still has agency in how that STEM component gets enacted for himself.

In another question youth are asked about how my feedback on their ideas are seen as genuine and not fake, and Ashley responds stating that their ideas are integrated. When collaborating with youth during planning it is not enough to just listen to their ideas with no action on their ideas. Youth's feedback and suggestions must be taken up and implemented into programming. This is not to say that I should only do what youth want because there is a level of structure that is needed for everyone to progress. However, it is made transparent to youth that the STEM program is *for* them and therefore their ideas matter and can come to fruition in STEM.

Vignette 1- "Ms. Ti'Era has options where we do something that we want"

This following vignette highlights the pedagogical practice of collaboration in planning through flexibility/adaptability. Collaboration in planning involves me being flexible/adaptable to youth's STEM interest. I share this vignette because it set the tone for our future interactions. By this I mean, youth and I were at the beginning phase of creating our STEM community and what that would look like because this was going to be a sustained program over the next two

years that met weekly. Previously when youth had engaged in STEM within the Teen Center it was not consistent, so youth viewed STEM programs as a quick and immediately satisfying. I say immediately satisfying because the STEM activities they did were able to be fully completed within an hour and youth would not return to the same project. Essentially making them one and done activities. This vignette takes place over a four-month period from September 2019 to December 2019. The initial STEM project was focused on e-textiles. E-textiles (electronic textiles) is embroidery with electrical light-up elements. However, youth were more interested in creating an art-based painting project that incorporated LED lights (electrical art). I look at the collaborative efforts of youth and I as we shifted STEM activities.

From September to November youth worked with embroidery. I brought handouts that showed up-close how to back stitch, stem stitch, satin stitch, and split stitch and encouraged youth try to embroider in ways that felt right to them. However, as youth worked with the embroidery, I noticed that after about three sessions youth became very tired of it. As I watched youth working, I was trying to observe why youth did not want to engage in the project. A few of the girls (including Sa'Ryah and Ashley) expressed that embroidery was too hard and they were concerned about the level of difficulty to get to the final e-textile project. When asked why they thought this activity would be so hard, they connected it to not having prior knowledge of how to embroider. Initially I thought maybe they just needed a break from embroidery, so I decided to switch to circuitry via paper circuits.

In November we transitioned to paper circuits majority of youth expressed that they were familiar with it and had done it in school or other programs. I saw this as a positive that youth had prior knowledge about circuits and therefore felt more comfortable with this activity. However about 15 minutes into the activity youth shared that they did not want to do paper

circuits either. I was very confused by this because the activity was going very well, youth were even sharing about the difference in the simple and parallel circuits to show their expertise. I immediately paused everyone working on the circuits and asked what activity they would like to do, that still involved STEM? Youth looked around at each other and then responded they wanted to work with art, but with something like painting. I acknowledged their interest and assured them that we could switch to painting. But I asked once again what the STEM component would be if they painted. Youth seemed unsure and did not know what STEM component to add. I noted their familiarity with paper circuits and suggested adding LED lights to their paintings. Youth agreed and I confirmed by recounting our new plan and how we would move forward. When we switched to electrical art, youth were extremely focused and would spend the entirety of programming designing their canvases. On a non-STEM day youth asked the BGC director if they could continue designing their electrical art.

Throughout the process of switching activities, I noticed a pattern that when youth felt that they would not be successful with an activity they were very resistant to continue. When we began with embroidery one youth had said, this is hard because I have never done this before. Youth needed a sense of accomplishment so they could feel that they were a doer of STEM. Even with my reassurance that they were doing just fine, that fear lingered. Youth were becoming overwhelmed by embroidery because they felt that they were not doing it right and would not be able to produce a *good* final e-textile project. Having the conversation about switching projects provided an opportunity for youth to have agency in how they wanted to move forward in STEM. They were clear that they wanted to paint but did not know what STEM component to bring in. I realized this was where I needed to step in and provide suggestions but

ensure them that it was *their decision* to make and I would support it. Figure 5.4 shows some of youth's electrical art

Figure 5.4: Electrical Art Artifacts



When I look back at Caleb's quote "She makes the atmosphere feel comfortable enough for us to express ourselves, she makes it enjoyable to where we can do things that she needs us to do and also what we want to do" this highlights the importance of changing the activity. I acknowledged in this moment that I was unsure how to move forward so I needed youth to tell me how they wanted to move forward. This prompted an immediate discussion between myself and youth about how we could move forward with their interests integrated into STEM, because my initial idea (e-textiles) was not in the best interest of youth. I did not want the discussion to feel tense which I kept reminding them that it was okay to share how they were honestly feeling. Like Caleb said, I wanted this discussion to feel comfortable because youth needed to know their ideas were key to programming. Our collaboration in planning is shown through my being flexible/adaptable. I was flexible/adaptable in my changing of the STEM activities. The STEM program is for the youth and I needed to make sure that activities were in alignment with their interests. This meant changing activities until they satisfied with the decision.

Theme 2: Stability of Critical Community

Youth Reimagining of Possibilities in STEM Space through Stability of Critical Community

Youth expressed the importance of having someone who they felt connected to that also made them feel like they wanted to come to STEM. Because of the sustained nature of the program youth have come to see their STEM program as a stable program. By this I mean youth have developed an expectation that STEM will always happen every week unless it is communicated to them that programs will not run on a certain day. Table 5.2 shares youth's responses that express the importance of having a stable critical community.

Table 5.2: Interview Responses - Stability in Critical Community

Question	Youth Responses
What are the range of feelings that you have in working with Ms. Ti'Era?	"Makes me feel like I want to be here and I should be here, when I don't want to do it she basically pushes me to do it" – Caleb, 15
What do you think Ms. Ti'Era notices about you that is different from what your science teacher notices about you?	"She notices if the energy changes, she knows if I'm sad when I walk in and a teacher wouldn't notice that, she notices what I don't have to say" -Ashley, 16 "She takes more time to get to know us on a personal level, how my day was, the tea, or the drama, she's like a personal counselor" – Sa'Ryah, 16
What does she do/stay to make you say that she is a person who cares and want to engage with me?	"She opens her mind, looks at from our perspective, rather than forcing us, she makes us want to engage. She doesn't do like I'm the staff so you're going to listen to me. She waits until we want to listen" – Sa'Ryah, 16
Is that different than how it is in school? (continued from previous question)	"We are forced to participate in school, and if we don't then they call home. But she waits until we want to participate" – Sa'Ryah, 16

Does it matter to you that Ms. Tee has been stable and consistent, how is that important to you?

“Yeah it’s the bonds.” – Ashley, 16

“Shows that she cares and wants to be here. The fact that she keeps coming means she wants to be here and enjoys it” – Caleb, 15

“Its means a lot to me personally, been at club since 5, staff is really come and go so I don’t take the time to engage and then they say they will visit but they don’t. for her to be here for two years means a lot because I trust her.” – Sa’Ryah, 16

“It shows that she cares and is not just doing it just to get paid. School science teachers just do it to get paid. Ms. Tee shows dedication that she wants to teach and wants to improve our science abilities – DaShaun, 14

“Dedication” – Jabria, 14

A common theme from youth’s responses that relate a stable critical community is being humanized by having their feelings acknowledged. To dig deeper into the importance of this I unpack Ashley’s response, “She notices if the energy changes, she knows if I’m sad when I walk in and a teacher wouldn’t notice that, she notices what I don’t have to say”. Ashley’s response brings up two strong points, first, she identifies the importance of me noticing how she feels even when she does not verbally express her feelings and second, she says that a teacher wouldn’t notice that. When I look at time spent with (formal) teachers and with myself, Ashley spends significantly more time with her teachers than with me. My time spent with Ashley is limited to once a week for about an hour and a half, but she is with her teacher Monday-Friday for about four hours each day. For Ashley to share that a teacher would not know how she is feeling equates not being seen. When Ashley walks in programming and I see that she is sad I immediately address it and engage in conversation with her.

Youth also aligned my consistency to caring about them. Sa'Ryah, who has been at the club the longest, provided insight to how staff is "really come and go" which has led to her not wanting to get to know staff. She named that my two years in the Teen Center meant a lot because she was able to develop trust with me. Sa'Ryah also shared "She (Ms. Ti'Era) takes more time to get to know us on a personal level, how my day was, the tea, or the drama, she's like a personal counselor". Developing trust is an important part of creating a critical community because it sets a foundation of expectations from the people in the community. Sa'Ryah has developed an expectation that I will show up to programming consistently and acknowledge what she has going on in her daily life outside of STEM. This is crucial because while the connection between youth and I is via STEM they come with many identities that do not center STEM.

Vignette 2 - "She Notices What I Don't Have to Say"

The second vignette is about two Black girls, Sa'Ryah and Ashley, and their initial resistance to participate in STEM. Their resistance was rooted in not wanting to work with a new "staff" because of the assumption, they would be there temporarily. This led Sa'Ryah and Ashley to not want to engage in developing relationships with staff or other adults in the Teen Center. Sa'Ryah and Ashley's resistance to engage in STEM was at its strongest when programming first began in September 2019. During this time the current Teen Director, whom Sa'Ryah felt a very special connection with, had just left. This vignette follows how Sa'Ryah and Ashley shifted from resistance to engagement in STEM over a 3-month period (September 2019 – December 2019). Their resistance was both physical and verbal until they began to see the STEM program

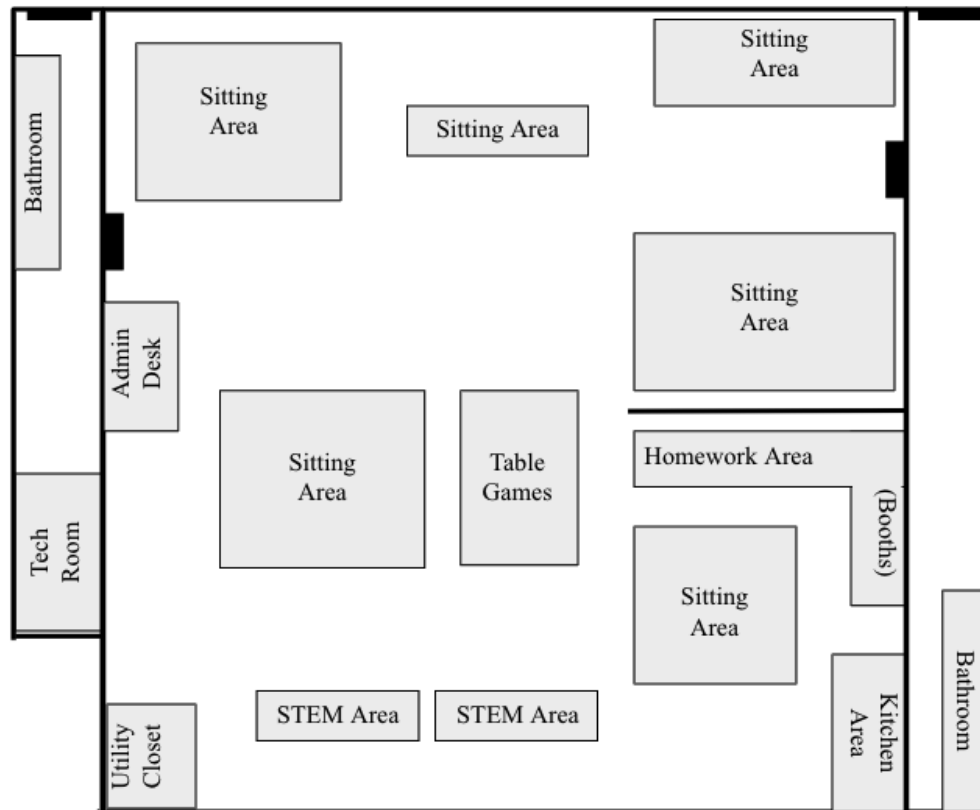
as a stable critical community, specifically a stable staff¹. This vignette supports critical community building through the humanizing of youth specifically looking at the acknowledgment of youth's feelings toward STEM and myself within the space.

When Sa'Ryah and Ashley were first introduced to STEM and me in September 2019 there was both verbal and physical resistance. Sa'Ryah and Ashley came to the STEM area to see what was going on. After a brief introduction Sa'Ryah stated "I'm not doing this (STEM)" and walked away and Ashley followed. They left to sit in an area that was designated as the homework space. They continued to go straight to the homework area until the BGC Director required them to do the STEM activity. Sa'Ryah and Ashley unwillingly joined, then Ashley said "this looks hard and I don't know how to do it". Since they were told to participate they decided to sit at the opposite side of the table. Because they did not want to get into any trouble with the director they continued to come to the STEM area but would not fully be *present*.

Sa'Ryah and Ashley both heavily resisted participating in STEM with both physical and verbal action. Right before the start of the STEM program, the Teen Director had recently left. The BGC Director had shared with me that Sa'Ryah and Ashley really liked this director and took their departure very hard. They created a boundary to protect their feelings which meant guarding them from me and therefore STEM. Their boundary was redesigned when the BGC Director required them to participate in STEM. Sa'Ryah and Ashley quickly adjusted their boundary to include physically being in the STEM space but kept their boundary about engaging in the STEM space. Figure 5.5 shows a layout of the Teen Center that includes the STEM area (tables) and sitting areas. The solid black squares represent doors.

¹ While I am not staff, I use the term in this vignette to describe myself because Sa'Ryah and Ashley see me as such.

Figure 5.5: Layout of Teen Center



When we shifted into the electrical art project around December, there was a shift in Sa'Ryah and Ashley's resistance. Ashley had been a strong advocate for electrical art so when she saw the canvases she began drawing. Ashley did not engage verbally, but she willingly grabbed her materials and got started. Sa'Ryah chose not to draw so she sat beside Ashley as she worked. This was the first time they did not resist together. Ashley finished up her design and was ready to add her circuit. I sat beside Ashley as she drew to initiate conversation with her. The discussion focused on Ashley's project such as, what are you drawing, what made you want to draw that, and where would her lights go. She drew Kermit the Frog, with some pink hearts around his head, on a light blue background with two white lights inside both hearts (Figure 5.6). Initially her circuit did not work and she yelled out in frustration, but did not leave the STEM

space. I tried to fix it alongside her but time ran out. In the next session I returned her project and explained that her circuit was right, the problem was that her battery was dead. Ashley looked at me with relief and then rolled her eyes to say, duh. As we wrapped up the art project Sa'Ryah decided to fully participate in STEM and approached me to explain her design. Sa'Ryah shared how she wanted to design her canvas and how many lights she wanted. I sat with her to help as she designed her art. As we sat together Sa'Ryah wanted to discuss her behavior in the program. She said "I'm sorry for the way I have been acting, but I was going through some things". I shook my head in acknowledgment and replied "I understand everyone goes through different things. I am just glad you hung in here and now you are completing your first piece of electrical art". Sa'Ryah smiled and said me too

Figure 5.6: Ashley's Electrical Art

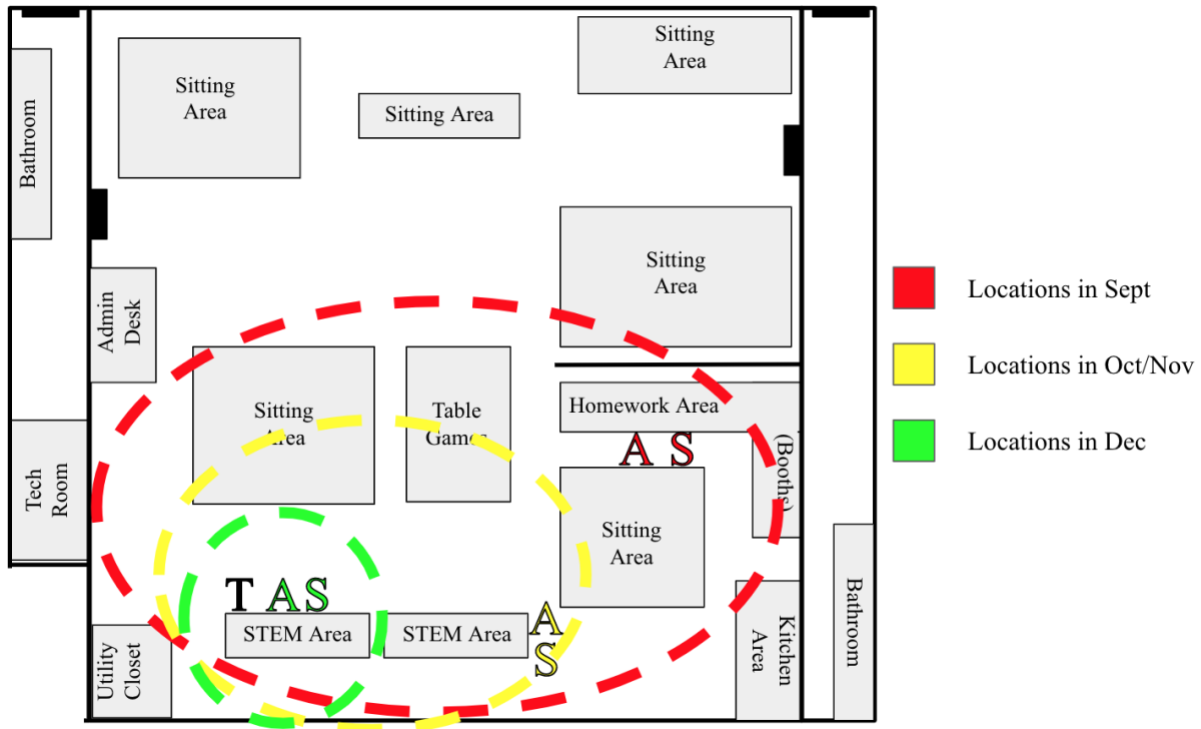


When we began to work with electrical art I see the boundaries being redesigned once more. Usually, they make collective decisions on whether they will participate but Ashley shifted her personal boundary to include engaging in STEM fully. When Ashley received her canvas she

immediately started on her design and worked on it for the duration of STEM. Even when Sa'Ryah chose not engage Ashley continued without her. I also see Ashley begin to ask for help instead of walking away. At first Ashley would become frustrated and leave the STEM area, but now she asks and waits for help. There is a shift in Sa'Ryah's boundary as well. When she acknowledges her behavior in the program and assured me that it was not my fault but her own personal emotions she was dealing with. This was a moment for me to acknowledge her feelings by letting her know it was okay to feel however she was feeling. Ashley and Sa'Ryah once again redesigned their boundary to embrace me and STEM.

Figure 5.7 shows Sa'Ryah and Ashley's trajectory of their movements toward the STEM area from September to December. Initials are used to represent where we would position ourselves during programming. The "T" represents myself and is black to show that I always remained within the STEM area. The "A" represents Ashley and the "S" represents Sa'Ryah. Over time I see how they recreate their boundaries by moving closer towards me and thus increasing their participation in STEM.

Figure 5.7: Trajectory of Sa'Ryah and Ashley's Movement Towards the STEM Space



Over the course of three months, I see the trajectory of Sa'Ryah and Ashley's participation in STEM. I had to acknowledge that I too was just another staff to youth, and while I was aware of my own intentions to consistently show up weekly, Sa'Ryah and Ashley would not know this without evidence. I took a step back and provided them time and space to heal at their own pace. By acknowledging Sa'Ryah and Ashley's feelings, through time and space, we were able to build a critical community through the humanizing by acknowledging their feelings. In the group interview Sa'Ryah named "taking time to get to know us on a personal level" and Ashley named "the bonds" as critical to creating a stable community for them. Their boundaries of protection are completely redesigned and now includes me and STEM, which means they have decided that I was no longer seen as staff who leaves. They are no longer resisting participation in STEM but instead embrace coming to programming. Ashley still becomes

frustrated when she is unsure how to move forward but now she asks for help instead of walking away and stays in the STEM area. Sa'Ryah still questions if she will participate at times, but she discusses that decision with me to help her decide how she wants to move forward. Sa'Ryah and Ashley now see the STEM space (myself included) as a stable critical community where they feel humanized.

Theme 3: Youth Actualization of STEM Capabilities

Youth Reimagining of Possibilities in STEM spaces through Actualization of STEM Capabilities

In the interview youth shared perceptions about themselves and my expectations of them in STEM. Some youth named their STEM identity or a STEM expertise they have. Within the STEM club there is an implicit rule that youth are expected to try. Youth tend to compare our STEM program to their formal science classroom, and how they perceive themselves in the classroom translates in the STEM program. This is more common when youth first join the program because they are trying to navigate what is expected of them in the STEM program. Table 5.3 shows youth’s responses about their actualization of STEM capabilities

Table 5.3: Interview Responses - Youth Actualization of STEM Capabilities

Question	Response
What are the range of feelings that you have in working with Ms. Ti’Era?	“Get away from all the commotion that’s happening outside of club, it’s having a fun time doing science, which I enjoy and building and creating stuff that you imagine in your head.” – DaShaun, 15
Do you feel Ms. Ti’Era holds high expectations of you and in what ways?	“She expects us to be great in life, gives us the tools to be successful, teaches us things that will help us in the future.” – Caleb, 15

	“Even a new person she expects greatness from everybody, expects us to be capable” – Sa’Ryah, 16
How do you know that, what does she do? (in reference to holding high expectations)	“From the way she approaches us, the way she comes to us as young gentlemen and ladies” – DaShaun, 15
How is Ms. Ti’Era different from your school science teacher at school?	“She actually wants people like us to do science (people who don’t like science), teachers at school do it for the money. Ms. Tee does it because she wants to help educate us in science” – DaShaun, 15
In what ways do you think you are a STEM expert?	“That’s a strong word. Putting stuff together I’m the engineer type.” – Sa’Ryah, 16 “Being the leader of the group.” – Trinity, 17 “I can teach them how to follow the rules but make it how they want and be creative.” – DaShaun, 15
Did you feel that Ms. Ti’Era involved you throughout the process of creating your project? In	“She asked for materials that we needed and the tools” – DaShaun, 15 “She let us do it hands on by ourselves most of the time and help us with little details, we went step by step but did it ourselves” – Jabria, 15

From youth’s responses I see that the validation of youth’s ideas so they see themselves as a doer of STEM was a contributing factor to youth’s actualization of STEM capabilities. For many of the youth in the program this is the first time in a STEM learning environment that they are being asked what they would like to create. This can feel unsettling to youth if they are unsure in their STEM abilities and do not know how to proceed forward. There is a level of agency youth want to take up but they need support for their ideas. For example, Jabria’s response stated “She lets us do it hands on by ourselves most of the time and help us with little

details, we went step by step but did it ourselves”. Here Jabria states the importance of doing activities on his own but still having the assistance when needed. He acknowledges his actualization of his capability to do the activities but at times may need help with smaller details. This is where he looks to an educator to be there for support.

DaShaun adds to this when he says “She (Ms. Ti’Era) actually wants people like us to do science (people who don't like science), teachers at school do it for the money. Ms. Tee does it because she wants to help educate us in science”. DaShaun ‘s response is in alignment with Jabria’s because while they identify their own STEM capabilities there is still the need for them to have me engaged with their work as well. However it is important to note that DaShaun perceives science teachers in school to teach for the money. Teaching for money means that he does not see teachers as people who are invested in his science capabilities, but rather as people who are just “doing a job” to receive pay. DaShaun even goes on to say “it’s having a fun time doing science, which I enjoy and building and creating stuff that you imagine in your head”. In this statement DaShaun sees the STEM program as a place where his ideas come to fruition.

Vignette 3 – “She actually wants people like us to do science”

The last vignette focuses on DaShaun and his experience determining the seating arrangements to create a plane prototype for a national STEM challenge. The STEM challenge took place from October 2020 to April 2021 during the Covid-19 pandemic. Below is the scenario youth worked on directly from the Cal Ripken STEM competition.

“Airline travel has been severely affected by the COVID-19 Pandemic with fewer people choosing to travel by air. A Southwest Boeing 737-700 currently has 143 seats on board. The CDC recommends staying six feet, or two arm lengths apart from others in public. Using both of these recommendations, redesign the interior of an airplane that

will enhance the safety of each passenger while keeping as many seats as possible to maximize the number of travelers per flight. Your design should include at least 100 seats on the plane while ensuring passengers are able to be properly social distanced. Please explain how your design enhances safety for all passengers and crew while maximizing the amount of passengers Southwest Airlines can fly.”

When youth were developing the plane prototype I was transparent that I supported their decisions throughout the process but their ideas would lead the development of the project. I emphasized that this meant they would really need to think collectively about how they wanted to move forward with ideas and materials. This vignette looks specifically at how DaShaun’s actualization of STEM capabilities through the validation of his idea so he sees himself as a doer of STEM.

DaShaun and Trinity decided they wanted to focus on layout of the seats when building the prototype. I created a large poster with important information about the plane, that included the layout of a Boeing 737-700, the scenario they were addressing (seating layout), and key facts about the plane and seating. So, youth could have something physical to work with during their planning, I had cardboard planes created with a laser cutter and brought Legos to use for seats, since they were small and moveable. In December 2020 youth began working with the 3D pens to create different parts of the plane. DaShaun began doodling with the pen and then decided to work on a seating arrangement layout. DaShaun first made a couple of seats and then began working on a “pod”. He said the “pod” would be a seating arrangement for family members. His thought was that if family was traveling together then they could sit beside each other. This

would remove the need for each seat to be 6ft away from another seat. Figure 5.8 shows the plane prototypes and DaShaun working with the 3D pen developing the “pod”.

Figure 5.8: Plane Prototypes and DaShaun Working on "Pod"



When I first thought about how to support youth in developing their prototype, I had the same thought as DaShaun about grouping seats and ran into the same issue that DaShaun was having. Instead of immediately telling youth my thoughts and what I had tried, I wanted them to engage in critical thinking for themselves. It is important for youth to have productive struggle because no solution was going to be finite. Instead, when DaShaun first stated that there needed to be grouping, I asked why he felt that and then encouraged him to follow that idea and think about it further.

DaShaun soon realized that with the 6 ft physical distancing rule and working with 100 seats that it was nearly impossible to follow that rule. He came to this conclusion when rearranging the Lego pieces on the plane. Throughout February 2021, DaShaun grappled with this idea using the tools provided: the informational poster, cardboard plane, and the Legos. He

then began grouping the seats on the cutout to try and fit 100 seats. I sat beside DaShaun to understand how he was thinking about moving forward with his idea. Below is an excerpt of our dialogue.

Ti'Era: how many seats were you able to fit?

DaShaun: I'm unsure. (Ti'Era started counting how many seats he had and there were about 45)

Ti'Era: (DaShaun is currently arranging the Legos) What do you think we can do to reach 100 seats?

Ti'Era: (Picks up lego to examine closer) They're too big. (He proceeds to put the Lego on top of the seat on the poster to check the sizing). The poster is bigger than the cutout but the seat size is still the same. I think Lego makes a smaller piece (we had a 2x2 size).

Ti'Era: Ok, this is just the size that the makerspace gave us because it's what they had. (DaShaun circles the Lego piece with his finger to show the smaller size that he would prefer, 1x1). Do we need a larger model and smaller pieces?

DaShaun: Yes, that's what I need to work with.

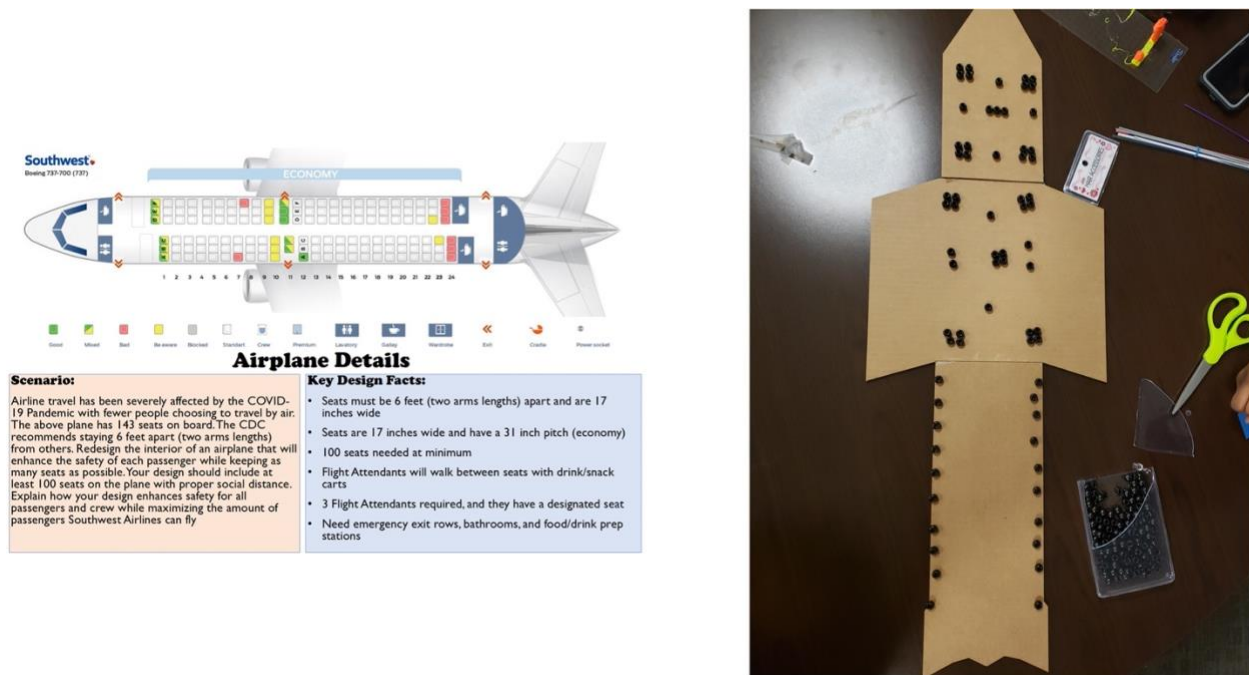
Ti'Era: (Writing down DaShaun's ideas) Is this correct? Is this what you need to move forward?

DaShaun: Precisely.

After the discussion with DaShaun, I brought in the materials he requested. The smaller Legos were not available so plastic beads were substituted for the seats. DaShaun laid a couple of beads on the new cutout and said they worked a lot better. DaShaun requested Trinity to help him arrange a new seating layout. They worked with the beads and kept referring back to the plane poster. By the end of programming, they had about 70 seats, which to that point was the

most they had been able to add. I took a picture of the current layout so they could remember it for next week. In the next session they continued right where they left off. I helped Trinity put beads back in place until DaShaun arrived. Trinity asked for paper and a marker so that she could keep count of how many seats were added to the plane. She calculated the number of seats and was now at 80. I acknowledged this and said she was so close she only had 20 more seats to go. When DaShaun entered programming, Trinity explained what she had done, and they continued to discuss where they should add seats. They would walk back and forth to the poster and discuss where they could place seats. I reminded them that they could place seats anywhere but to be aware of the pilot station, the bathrooms, and the food storage in the back. Figure 5.9 shows the poster they were using along with the plane prototype (to scale) and the beads.

Figure 5.9: Plane Poster & Final Prototype



Soon Trinity and DaShaun shouted, “We did it we have enough seats”. Trinity then began to add up the seats to see how many they had, she realized that they had 103 seats on the plane,

which was more than required. After trying different methods DaShaun realized that he needed different tools. I worked with him by actively listening his ideas and pushing his thinking by probing him to explain his ideas. When DaShaun identified the tools needed to move forward, they were brought the following week. DaShaun tested the tools to see if they would help him with the seat configuration. This series of actions led DaShaun and Trinity to successfully figure out the challenge.

When I first introduced the STEM challenge to youth I was very transparent that youth would be leading the project with my strong support. As I observed their progression, I would bring in tools and share information from my experiences on planes. DaShaun decided to take lead on the most important part of the plane, the seating layout, and decided to pull Trinity in with him. DaShaun had an idea about how the seating layout should be designed so I asked probing questions about his thoughts. Probing included; *what are you thinking?*, *why is that?*, *do you want to move forward with that idea?*, *what do you need from me to get that done?*. From the probing questions DaShaun was always centered and this was a means to validate his ideas. DaShaun shared in the group interview that he enjoys building and creating stuff that he imagines in his head. The seating arrangement of the plane was completely imagined by DaShaun and he was able to bring his idea to life. Through validating his idea I provided DaShaun a form of confirmation that he was on the right track. When I would ask probing questions the focus shifts to DaShaun and he is able to critically think through his idea while in dialogue with me and unpack his own decisions. Once he had the materials that he requested he was able to “test” whether his idea would work. When DaShaun was able to get 100 seats on the new plane cutout he came to the actualization of his STEM capabilities and affirmed himself that he knew what he was doing.

Discussion

I set out to understand how the Teen STEM program served as a BES for Black youth and to examine the pedagogical practices that led to such. The pedagogical practices include collaboration in planning specifically flexibility/adaptability, the acknowledgment of youth feelings that led to a stable critical community and validating youth's ideas so they see themselves as a doer of STEM. RQ 1 looks at how CBES served as a BES for youth to reimagine the possibilities of engaging in STEM-rich making. What was surfaced were how BES serve as a socio-spatial imaginaries rooted in anti-Blackness and the criticality of educator-youth relationships and their effects on youth engagement in STEM. When I look at the design of the program two characteristics were identified. The first being youth were able to be unapologetically Black while engaging in STEM and their perception about STEM spaces, as well as themselves in the STEM spaces, shifted.

Being Unapologetically Black While Engaging in STEM

Within this co-created STEM space youth were able to navigate what engaging in STEM looks like when they did not have to sacrifice parts of their identity. Referring back to Warren and Coles (2020, p. 391) conceptual model for BES, these sites are created at the intersection of fugitivity and racial counterspaces. The BGC serves as a racial counterspace because it is the physical location that is focused on supporting whole-child well being through community-building. It is also important to note that both the youth and staff at BGC are predominately Black. Fugitivity was supported in the STEM program as it is not bound by location and youth are able to find Black joy and freedom in STEM through their rightful presence. At the intersection of these two dimensions are where I find the three themes of BES; 1) youth agency

in decision-making, 2) stability of critical community, and 3) youth actualization of STEM capabilities.

When I look at the contributing factors that set the foundation for the imagined STEM space, I see that youth are surrounded by the opposite of anti-Blackness. In the group interview Caleb stated she “makes me feel like I want to be here and I should be here”. In our STEM space youth are supported and encouraged to engage in STEM in ways that work for *them*. This is seen in their agency in decision making through the collaboration in planning for youth engagement in STEM. The collaboration in planning meant being flexible/adaptable to youth’s wants and needs as we progressed in STEM. This also included acknowledging youth’s STEM experiences and how that would influence our STEM activities. For example, when youth are working on a STEM activity and become overwhelmed or frustrated, they may ask if they can continue STEM while listening music or ask if they can step away for a moment. Youth also may make the decision to depart from the STEM space entirely without asking, like in the vignette about Sa’Ryah and Ashley. This act of freedom is expressed in Sa’Ryah’s response, “she waits until we want to participate”. Because BGC is a racial counterspace Sa’Ryah and Ashley felt comfortable to walk away from STEM. Overtime they realized that in the STEM space they still had agency in deciding *how* they wanted to participate and for how long.

Shifting Perception About Places and Selves in STEM

When I look at how the STEM program served as a BES, I see it as a socio-spatial imaginary rooted in anti-Blackness. My reason for naming the STEM space as a socio-spatial imaginary is because there is no designated area for STEM. The layout of the Teen Center is a very open floor that consist of tables and chairs arranged in ways that make it sectioned off. The Teen Center also represents a space where adults are transient, and youth are permanent. In turn

the STEM space is more defined by time and people than place. While the STEM space has no finite location it is identified by time of programming and wherever we are gathered. By identifying the STEM space more through the construct of time and people and less by the construct of place it opens the possibilities of how youth perceive STEM as well as their perception of themselves in STEM.

Looking across youth's group interview, many youth juxtaposed the STEM program with their formal science classroom. Their perception about both STEM/science were negative because as DaShaun said "(formal science) teachers were in it for the money" and did not support youth to develop their STEM identity. Youth positioned formal science teachers as people who did not care whether they succeeded or failed in science and as people who did not know them very well. This led youth to perceive STEM to be "hard" because of this lack of support. Both perceptions contributed to youth feeling that they did not belong in STEM/science. Over time as youth's ideas about how to engage in STEM were validated they began to see themselves as a doer of STEM. Because youth now viewed themselves as people who do STEM they began to name their specific STEM identities; "Putting stuff together, I'm the engineer type" (Sa'Ryah) and "(I'm an expert in) 3D Printing" (Caleb). However, it is important to note that youth made sure to always align their, now positive, STEM experiences to our co-created STEM space.

RQ 2 addresses the pedagogical moves for informal STEM educators to develop such learning environments that counter anti-Blackness. When I zoom-in on the pedagogical practices, it was key that youth and I collaborated in planning which allowed for flexibility/adaptability, their ideas were validated so they saw themselves as a doer of STEM, and a critical community was developed by acknowledging youth's feelings . Through that

flexibility two themes became emergent when examining the pedagogical practices in the program, first was acknowledging prior adult-youth relationships and its current presence and second is the importance of fluidity within CBES to support youth interests in STEM.

Acknowledging Prior Adult-Youth Relationships and its Current Presence

From vignettes one and two I highlight how youth's previous experiences with adult STEM educators and adult staff was still present as they tried to navigate what a relationship with me would look like. Aspects of my critical relationality with youth were nested within a negative nature of relationality at the Teen Center. I saw this surface in two ways, the first being represented in vignette one where youth perceive STEM programming to be a one-and-done session without any connection amongst activities. Their previous experiences with adult STEM educators in the Teen Center had not been consistent. When I proposed sustained STEM programming that contributed to the progression of STEM expertise youth push back on this idea by expressing how tired they are of doing the same activity. Youth engaging in the same activity as repetitive rather than developing expertise. Youth were not familiar with a stable critical community with adults which made it challenging to introduce a sustained STEM program.

In vignette two, Sa'Ryah and Ashley resist STEM programming because they resist developing a relationship with me. As mentioned previously, Sa'Ryah stated that people (adults) do not stay here long so there is no point in opening up to them or expecting them to stay. When we began programming in the Teen Center, I could have dismissed youth's history towards the adults and pushed the notion that we would "start fresh". I did not consider this best practice and wanted to acknowledge their feelings by respecting the historical aspect of critical relationality. From my standpoint youth did not automatically owe me their full respect and acceptance. This meant that respect and acceptance are to be earned through being in community with youth

through sustained time and engagement. This is a clear example of actions speaking louder than words. This is also confirmed in their interview responses; “it’s the bonds” (Ashley) and “she takes more time to get to know us on a personal level” (Sa’Ryah). It was not enough for youth to hear me say that I would teach STEM weekly over the next two years. Youth needed to see me show up weekly and teach STEM. By acknowledging and providing space for youth to express and navigate their feelings about their prior experiences with adults, youth felt humanized which allowed us to establish a new stable critical community.

Fluidity of CBES to Support Youth Interests in STEM

CBES are seen as sites of pedagogical possibility because of the flexible nature of the space (Baldrige, 2011). Two of the key characteristics of CBES are flexibility and shifting of power dynamics. From the group interview Ashley shared “She make it fun like where it’s to us. She listens to our suggestions”. Looking back on vignette one I see how I was receptive to youth’s interests. I noticed that youth were becoming disinterested in the e-textiles project. There were two options for myself moving forward; make it a requirement for them to finish or be flexible in my curriculum and change the activity. I also highlight that it would not be sufficient to ask their input for a new project and then not follow through on some of their suggestions. Youth were very clear that they wanted an art-based project where they could paint. For youth to be asked for their input and see it come to fruition was key for them to see that I was being accountable in my pedagogical practice. By being flexible in my plans and adapting to youth’s interest we collaborated in planning to switch to a better STEM activity.

Youth interests in STEM were also supported during the STEM challenge by creating a prototype that was emergent of their ideas. I wanted to ensure that youth felt they were at the forefront of developing their plane prototype. This was key because since this was a STEM

challenge youth would be responsible for presenting about their plane. I wanted them to show their expertise and exude confidence by having a full understanding of the parts they had developed. This is not to say that I did not contribute to their ideas but it is to highlight the need for validation of their ideas so that youth saw themselves as a doer of STEM.

Tensions

While there were positive takeaways from co-creating the Teen STEM program with youth there also many tensions that surfaced. Two tensions I found myself navigating constantly were: historical relationality of STEM (school science and at BGC) and allowing time for youth development. These two tensions were very critical to both myself and youth because how we navigated it was key to shifting youth's perception about STEM and STEM educators. For example, as I would introduce different STEM activities to youth, they would automatically link that activity to their school science class or a STEM session they had at BGC. Usually, these experiences were not positive which would automatically lead youth to think negatively. This form of resistance would show up as "this is too hard" and "I'm not good at this in school". Youth tended to lead with these statements which would add another layer of difficulty to support them.

This leads into the second tension of time for youth development. Because of the negativity that surrounds STEM for youth, it can take multiple sessions (weeks or months) for them to see themselves as a doer of STEM. For example, Sa'Ryah and Ashley took four months to begin to see STEM as an activity that they enjoyed. As an educator navigating previous STEM experiences and the time for youth to come around can be daunting. While I do not create full lesson plans, I still have to plan what youth will do when they come to STEM. As an educator it is not ideal to constantly change plans because I must prepare materials and bring them to youth.

However, I am fully willing to make these changes to support how youth are interested in doing STEM. When I look at time for their development, the uncertainty of how long it could take them to shift to a doer of STEM is challenging. In alignment with the planning, I want to move youth along in STEM to show them the possibilities, however I must be very patient as youth take the appropriate steps for what they need.

Due to their nuanced history with STEM, it becomes imperative that I validate their ideas so they see themselves as doers of STEM. When youth have opportunities to explore their own ideas I become a bridge by showing how their interests connect with STEM. When youth come to the actualization of how their personal interests align with STEM it changes their outlook of themselves in STEM. It is also important to highlight that youth need to be humanized in their moments of uncertainty and struggle. Youth come in with many contributions but their history with STEM causes them to be nervous with expressing those contributions. When youth feel humanized and come to the actualization that they do have something to contribute they become engaged in ways that even I may not have considered. However, without the fostering of youth they usually do not have the opportunity to reach this actualization.

Conclusion

The design of the teen STEM program have shown that the role of the educator is critical in supporting Black youth and youth's STEM interest are interconnected with many confounding factors in their lived experiences. Youth do not enter these spaces as a blank slate ready to be shaped into a person who does STEM. They instead need time and support to understand what it means to engage in STEM as a Black youth. When youth and I first stepped into our STEM program everyone arrived with their perception of how the program would go. I expected youth to be ready to do a long e-textiles project that I had enjoyed doing. Youth expected me to be

there for a short time span and have a one-and-done activity. Our socio-spatial imaginaries of how we came to know STEM and educators who teach STEM were not in alignment.

Over time our newly developed socio-spatial imaginary began to shift from just a STEM program to a stable BES that was undergirded in the principles of Black Love. Youth exercised agency in their decisions about STEM whether it was if they wanted to participate or what they wanted to make. A stable critical community was established where youth developed expectations of what it meant to have a consistent program and educator. Last youth came to the actualization of their STEM capabilities by being afforded consistent opportunities to have agency in how they learned and developed expertise in STEM.

This BES was established through fugitivity and racial counterspace. The racial counterspace was developed through critical community building through the humanizing of youth, specifically by acknowledging their feelings towards staff and STEM. Youth entered the STEM space with weight of negative science experiences and being abandoned by staff. By the end of programming youth became excited about STEM and feel secure that they would not be left. The fugitivity was through youth having their ideas validated so they could begin to see themselves as a doer of STEM. Youth started programming feeling unsure about how they saw themselves in STEM but over time were able to name their expertise. Fugitivity also happened through collaboration in planning, specifically the flexibility/adaptability of the program. As participants in the STEM program youth expressed what they wanted to see implemented into their activities and projects. Because of the educators pedagogical practice activities were able to changed, to best fit youth's needs.

Youth were able to reimagine the possibilities of what STEM is and how it is taught. For me this meant navigating the tensions of historical relationalities in STEM and taking the

necessary time for youth to develop their STEM identities. These tensions are hard to navigate because of the uncertainty around them. This required me to quickly adapt to what youth needed to move forward. While I understand the necessity of the flexibility, it still proved challenging to navigate because I wanted to uphold youth's expectations. Moving forward this leads me to look deeper into the varying perceptions of how youth see the role of the informal educator vs how I see the role of the informal educator. I explore this in the next chapter that is an autoethnographical study of my position as a community-based informal educator.

CHAPTER VI: I MATTER HERE: A CRITICAL AUTOETHNOGRAPHY UNPACKING THE
RIGHTFUL PRESENCE OF AN INFORMAL STEM EDUCATOR

“Mom, this is Ms. Tee. I used to not like science but now I like science because of her.”

- Tremaine

“She takes more time to get to know us on a personal level, how my day was, the tea, or the drama, she’s like a personal counselor”

-Sa’Ryah

Introduction

What does it mean to educate Black youth in STEM within an informal community-based setting? Well first I say be prepared to take on many roles. From the above quotes made by youth, my role as informal STEM educator is multifaceted. As I reflect on my own upbringing and experiences as a STEM learner from elementary to the undergraduate level, I wonder what the possibilities could have been if I had educators who created spaces for me to engage in STEM in the ways that I wanted. In my role, I often reflect on *how* and *who* I want to be for youth. My pedagogical practices are in direct correlation to what I needed for myself during my upbringing. While I cannot revisit my childhood, I make it my goal to create spaces where youth can have the supports they need. However, in reauthoring spaces for youth I also create space and community for myself. Alongside these youth I too, am provided opportunities to continue my own exploration of STEM. This critical autoethnography explores what it has meant for me, a Black woman who loves to tinker, to teach STEM in non-traditional ways and discover my own rightful presence in STEM and STEM education. I draw from my experiences as a child, an undergraduate, and as an educator, how that influences my current pedagogical practices. I use

this critical autoethnography to answer the following research question: in which ways do informal STEM educators utilize community cultural wealth to establish rightful presence?

Theoretical Frameworks

To frame this work I draw from community cultural wealth (Yosso, 2005) and rightful presence (Calabrese Barton & Tan, 2020). I draw from these two frameworks because as a child I was strongly rooted in my community and was shown the value of seeing my community as a wealthy resource. I draw from rightful presence because as a direct result of understanding how to enact community cultural wealth I established my rightful presence within a local Boys and Girls Club (BGC).

Community Cultural Wealth

Community cultural wealth (CCW) is the knowledge, skills, and abilities learned by generations of communities of color to survive in an oppressive world (Yosso, 2005). Wealth is usually associated with monetary income and grows over time but it is also known as the value of one's accumulated assets and resources. Yosso (2005) identifies six forms of capital that contribute to CCW that include aspirational, navigational, social, linguistic, familial, and resistant. Aspirational capital is the nurturing of future possibilities even through the real barriers that one faces every day. Navigational capital is knowing how to maneuver within social institutions that were not created for people of color. Social capital is seeing people as resources and understanding how to utilize them. Linguistic capital is understanding how to communicate with others in different places. This is not limited to native languages (i.e., Spanish, English) and can include the ways in which people talk, in different locations (i.e., university, specific communities). Familial capital is the knowledge that is fostered directly from family. This is not limited to immediate family or direct kinship but can extend to those who are considered

members of the family. Last is resistant capital which are the skills learned through challenging inequality.

Rightful Presence

Rightful presence (Calabrese Barton & Tan, 2020) “focuses on the processes of reauthoring rights towards *making present* the lives of those made missing by the systemic injustices inherent in schooling and the disciplines” (p. 4). Rightful presence goes beyond youth having access to a space as an equitable opportunity. It asks the question if youth have been extended the right to feel that they can authentically be their whole selves within spaces. Rightful presence has three tenets; allied political struggle, rightfulness established through presence, and culture of disruption. Allied political struggle is the challenge that one endures to extend the rights to reauthor, and undergirds all three tenets. Rightfulness established through presence makes known the intersections of injustice in youth’s lives and disciplinary learning that lead to new possibilities. Culture of disruption is moving from the traditional practices seeped in dominant ideology through the reauthoring and extending of rights that lead to shifts in hierarchies of power.

Methods

Critical Autoethnography

To navigate how my experiences inform my pedagogical practices, I employ critical autoethnography. Critical autoethnography emphasizes intentionality and self-critical awareness (Boylorn & Orbe, 2014, p.6). It focuses on understanding lived experiences of people in context by examining oppressive conditions and social realities. Through my lived experiences, I seek to understand how culture and power come to the forefront of my experiences as an informal, community-based STEM educator. Through self-interrogation and cultural accountability I use

my lived experience as epistemology to provide a counter-narrative of what it means to be a Black woman, informal STEM educator (Boylorn & Orbe, 2014; Toyosaki, 2018).

Experiences in STEM

To further illustrate my Black Love framework and explain my positionality, I unpack my identities in STEM as a child, as an undergraduate student, and as an educator focusing on how they have played an integral role in how I see myself as an informal STEM educator today.

STEM as a Child

As a child (and even today) my greatest joy was to be able to take something apart and put things together. I loved learning how things worked and what they were made of. My parents fostered this curiosity by always encouraging me to stay with that passion. My dad was known as a fixer and I loved being his little helper and following his every step to see what project he had to do around the house or in the shed. My mom was quick to say she was not blessed with knowledge of knowing how to put things together, but she knew how to ask around. As I would fix and take apart things around the house, they were always quickly followed by moments when I did not know what to do next. My mom always knew when I hit these moments of frustration and would immediately ask, You got it? I would always respond saying yeah (not wanting to admit defeat) and continue working to figure it out, but my mom always knew when to check in. As both my frustration and determination grew, she would check in again and ask, “well do you know what you’re doing?” Again, not wanting to admit that I did not know what I was doing I would say, yeah. Then would come the “test”, my mom’s final question –“well explain it to me.” So I would explain step by step what I had done, why I did it, and what I planned to do. Although my mom usually would not understand what I was saying, she would never dismiss my thoughts. Through talking with her about my own thinking, it helped me clarify my own

thoughts and think about how I wanted to move forward. This was in direct contrast to how I was able to solve problems in school.

At school there was no exploring solutions there was simply, listen to the content, copy the content, memorize the content, and ace the content. As a Black girl who was labeled as “one of the good ones”, I knew there was no room for error or uncertainty. Every time my hand would raise to answer my teachers’ question it felt like a battle to defend the label that was placed on me, because God forbid I ever lose it. I was very aware that school and home were different and would wait until I got home to really tease out my thoughts. I knew my parents would work with me and let me think through many ideas and solutions.

In 5th grade I had a school project where I had to make a totem pole for a history project. This was my first school project and I had no idea what to do but was excited to make it. I told my mom about the project and we immediately went to Michaels (an arts and craft store). This was our first time in Michaels and we were overwhelmed yet excited by the options. We bought the materials needed and returned home. The totem pole was created using three posterboards taped on top of each other, to give it height. We taped the posterboards to the wall in the dining room and then began planning. My mom knew I was likely to start drawing without a plan so before my pencil touched the poster, she asked what my plan was. From what I learned in class and by looking in our encyclopedia set, I knew that totem poles had significant meaning and told a story. She asked what my story was and at the moment, I did not know, so she went and got some paper and told me to plan out my story. Once I had the story, we were ready to draw. My mom knew I did not like drawing nor was I very good at it, so she took the role of encouraging me in my drawing, and if I was really struggling then she would help me draw the figure. My mom is not the best artist either so when the drawing felt that it was above both of us, she would

talk with my dad and ask who we knew, that could draw very well (or at least better than us). My dad named some of his cousins but they lived too far away. My mom thought about her cousin, Rabbit, since he lived closer and was able to come to the house and help me. Before Rabbit arrived, she was very adamant that when he was helping me draw, it did not mean I had a break. It was *my* project so I needed to watch what he was doing so I would know how to explain my project to the teacher.

Once all the drawing and painting was done, we had to assemble the pole. We took it off the wall and rolled it around, taping it in the back. However, we ran into an issue because the pole was off balance and kept tipping over. My mom and I could not figure out what was wrong so we waited for my dad to get home from work. We told him what the problem was, and he picked the totem pole up and said it was too light. He suggested putting balled up newspaper inside the totem pole so it would have some stability. The newspaper helped but the totem pole was still tipping over. I suggested that we needed something to put at the bottom of the totem pole like a base, but I did not know what material would work best. My dad went to his shed and my mom and I walked the house looking for anything suitable. My mom found some foam and asked if it would work and my dad felt it would so he cut the foam to put at the bottom of the totem pole and it stood on its own. We then added more newspaper to make the totem pole sturdier and then finally it was standing on its own (Figure 6.1).

Figure 6.1: 5th Grade Totem Pole Project



I learned at an early age how to be resourceful with both material and human resources. My household was one of the many examples of how historically, Black households have been rooted in Blackness and STEM expertise, both contributing to our community cultural wealth. This contributes to my culturally STEMulating interest of tinkering because at home and within my communities I continued this generational capital of Blackness and STEM expertise. My parents would always pull on every resource they had access to, to ensure my rightful presence in school. I grew up understanding the value of aspiration, familial, and social capital. My parents aspired for me to do better than them and succeed in my studies. I grew up being rooted in community and understanding that I should lean towards them by asking for help rather than being prideful and not getting the help needed. In relation to the Black Love framework my STEM experiences as a child were where active noticing, including JiT teaching and culturally STEMulating factors, and validation of my ideas so that I saw myself as a person in STEM were strong. My mom actively noticed that I was passionate about taking things apart and assembling

them back together. Because of this, she knew I was culturally STEMulated to always work with activities that involved tinkering aspects. My dad was representative of JiT teaching because when I would become stuck in my activities he would step in and help me so I could continue. Lastly whenever I was unsure about solving problems at school or home, I knew my family was a safe space where my ideas were validated so I could see myself as person in STEM.

STEM as an Undergraduate

When I started college I attended a public university in North Carolina. I was accepted into their college of engineering, specifically mechanical engineering. I chose mechanical engineering because my family and I knew my strengths were problem-solving and putting things together. It also felt so prestigious to have this the title of mechanical engineer especially being a first generation college student. The first year went well and I enjoyed my calculus and chemistry courses. As I entered the second year I enrolled in physics and everything began to falter. Physics was a course that was required for matriculation into the engineering major and without a C- or better one could not become a Mechanical Engineer. This prompted an internal battle because I was not a student who failed courses or gave up--what would it say about me if I did not become a mechanical engineer? Being the determined person I am, I quickly made an appointment to speak with the Dr. Phan (pseudonym), Director of Undergraduate Advising within mechanical engineering. I made this appointment ready to learn what my options were in getting back on track to become a Mechanical Engineer. I walked into Dr. Phan's office excited that I was about to receive some much-needed help, but I left more disturbed that when I entered. I walked in, introduced myself, and shared my struggles in the physics course. Without even giving me a second glance in between her coffee sips, Dr. Phan said, "Well mechanical

engineering is a physics based major so if you can't hack physics then you probably can't hack the major, so I would look into something else.”

I felt that my dream had been snatched before my eyes. It all felt so final and real that I was not going to become a Mechanical Engineer. At this time, I did not believe in changing my college major, because I equated changing majors to not being serious about school. In the media (movies and tv shows) when characters changed majors, they were usually associated with being indecisive, changing majors for relationships, or trying to find an easy way out. I fit none of these stereotypes and being a first generation student I simply felt I was not allowed to change. What would be said about Ti'Era, the Black girl that defied the odds and made it to one of the best universities in the state, if she returned home because she was not good enough? Determined not to leave engineering, I started asking about the other engineering disciplines (e.g. industrial, electrical). I knew deep down I did not want to enroll in these majors, but I could not let engineering go. I finally shared with my parents about my dilemma with my major, fighting back tears because I did not want to be seen as a failure. They stopped me in my tracks and assured me they were proud of me no matter what I did. My mom, knowing just how determined my personality was, asked if I had looked into *every* possible major at this university and if I talked with anyone else about it. I had not really done the proper exploration of all possible majors but promised her I would.

I set up an appointment to speak with the Coordinator of Advising (in the college of engineering), Dr. Simpson (pseudonym). When I entered her office, she greeted me and smiled and asked how she could help me. As soon I sat down in her office, I started crying. Dr. Simpson paused grabbed tissues, sat beside me, and told me to take a moment for myself. After getting myself together, I explained that I needed to switch majors because I was not doing well in

physics but honestly did not know which major to choose. She nodded her head and then asked me what I wanted to do as a career, what made me choose mechanical engineering in the first place? I began to explain how much I loved hands-on work and coming up with solutions and understanding how different things function. Dr. Simpson saw the happiness return to my face, and said, “I think I know where you belong”. She suggested I look into the agricultural and environmental technology major because it perfectly suited what I described. The only caveat was if I enrolled in this major, I would still be considered in an engineering field (biological and agricultural) but I would not graduate with engineer as my title. Without a second thought I said, “That’s fine with me as long as I get to do what I want”. The agricultural and environmental technology major was very hands-on and problem-solving based, giving me exactly what I wanted. I took physics for the fourth time and passed putting me back on track and then I graduated in 2013.

Entering into university, I was immediately faced with the struggle of authoring my rightful presence. I had been taught how to use my social capital, but I was no longer at home in a familiar surrounding. I had to learn how to navigate this new space while being resistant to the rules they had in place. Being a first generation college student I had this outlook that changing my major was not an option because it would mean that I was not serious about school. In reference to Black Love by maintaining high expectations of *my* STEM expertise and ability to do rigorous STEM now I exercised my resistance capital. I used this to help me navigate through the people I needed to speak with, I created a path towards a major that was fitting for me. It also changed my outlook on creating plans because initially I had one plan, to become a mechanical engineer. But after talking with Dr. Simpson, I was reminded that it was not about the major/label but it was about being able to do what I was interested in doing.

STEM as an Educator

My experiences with STEM as an educator started with environmental education. In 2014 I was a summer intern working with a nature camp for underserved youth. I did not think I would be good at this job because I did not have any training in teaching youth and definitely did not feel qualified to teach environmental education. While I had my own outdoor experiences that included playing, helping my grandad on his farm or my dad in his shed, I did not think these were the “acceptable” types of experiences that they were looking for in this field. The following year in 2015 I continued my path with environmental education and served as an environmental volunteer in the Peace Corps.

The Peace Corps is a government organization that has three main goals: 1) support interested international communities to meet the need for trained men and women, 2) promote better understanding of Americans and, 3) promote better understanding of the people in the country of service. My site was Zaña², Perú and I served from 2015-2017. As an environmental volunteer my main three goals were: 1) environmental awareness, 2) management of natural resources (tree planting), and 3) management of solid waste (recycling). Because volunteers work on the ground at the community level, we had to be very intentional about integrating into the community. Here I learned my most valuable life lesson, communities work based on trust, not credentials, and to be involved with and working alongside the community is to become a part of the community. Zaña did not care about my degrees. They cared that I showed up to their daughter’s baptism, their son’s graduation, town meetings, birthday parties, and lunches/dinners.

² Town in Northern Peru in the province of Lambayeque, known for their Afro-Peruvian population and ruins

My work as a volunteer was not limited to my job description, it was more than that because I was being seen as a welcomed member of the community.

When I first arrived in my site, Zaña, I had high expectations that I would hit the ground running and be able to start environmentally-based projects immediately. After all, they requested an environmental volunteer so this must mean they were ready to support me as well. Within a month, my expectations were dropping by the second because I was not able to successfully implement any projects. My immediate thoughts were filled with doubt because it felt like I was failing at my job. What did it mean for me if I could not do the work, because *Ti'Era* does not fail. I thought maybe I was being too ambitious and I should scale back some. I decided to go to the local elementary school and teach English because I remembered how much they valued English. I asked the principal if I could shadow a few classes to learn the classroom culture and he happily agreed. Soon I was given six sessions of English courses to teach, then three sessions of summer camp, then an environmental club. I soon branched into other projects in the community that included working with the health center, the municipality, the town museum, the high school, and the cultural center.

Much of my work was centered at the elementary school with the upper grades. My main roles were the environmental and English educator. Because I was basically left to do my own thing and figure out how to teach youth I was always trying different activities and pedagogical practices. As youth trickled into my programs, I wanted to be very open with them about my shortcomings and be clear about the expectations. The main shortcoming for me was the Spanish barrier. I would remind youth that my first language was English, and Spanish was a challenge for me, so I expected them to help me by correcting me if I said something wrong. Youth were

not used to this kind of candidness with an educator but they loved to help me learn the language.

When we began focusing on environmental topics, I leaned heavily on their expertise. I wanted to know what they thought of the natural environment in their town, because this would be the base of how we set up projects in the future. Youth initially did not think they had anything to contribute to the conversation. I assured them they did and began drawing boxes and lists on the board for them to fill out. After much probing with no responses, I asked who had been in Zaña since they were born, to which they all raised their hands. I then asked who walked around town everyday, and again all hands went up. Last I asked who knew the most about Zaña, and with many giggles everyone was fighting over who knew the most about their town. After this confirmation I said, see you all know something about your environment. I went back to the problems list and asked if anyone knew of an environmental problem with the river, the trees, or the ground. Slowly hands went up with solutions. I encouraged them to write their solutions on the board and slowly they went to the board to write (Figure 6.2). After they filled the board with responses, I said look at all this information that you know, that I would not have known without your help and thanked them.

Figure 6.2: Youth Writing Solutions on the Board



When I arrived in Perú my linguistic capital faltered because of the language barrier. However, I realized that although I struggled with the Spanish language I still had linguistic capital in knowing the English language. Though English was not common in my site, it was highly valued. I used my English to start working with the schools and integrating into the community. Integrating into the community supported me to learn the rules and norms. By learning the rules, I was able to disrupt the rules and when I became the educator of a small group I was in a position of power to support youth to develop their rightful presence. I drew from my experiences as a student and remembered how following traditional rules of school made me feel like I was not truly welcomed in certain spaces. I never wanted to make a child feel this way, so I became intentional with how my learning spaces were designed.

This is where the critical relationality focused on integration of youth voice and interest from the Black Love framework emerged. In working with the youth I would collaborate with them on their planning. This meant asking about their interests and thoughts on how we should move forward. This meant being flexible/adaptable as well as transparent/accountable. What I

would initially plan for youth may not be the way in which they wanted to move forward. I also made it a point to be transparent/accountable about what we would do in programming moving forward and why those decisions were being made. Critical community building through humanizing youth meant acknowledging their feelings, learning and using their names, and making space for critical conversations. Youth were uncomfortable with speaking their ideas because of their traditional schooling practices. Our informal programs became a space where youth's feelings were acknowledged and addressed, their names were pronounced and spelled correctly, and all conversations were welcomed.

Context

The context of the finding takes place within both informal STEM programs (Green Club and Teen STEM Program), where I have dual roles as researcher and educator. At the BGC youth have fostered a community where they have a strong bond and sense of ownership. Youth have significant agency over their work and space (e.g., moving freely in the room, visiting other friends to look at their work) and a lot of input with how weekly programming goes.

Data Sources

Data sources included personal experiences, fieldnotes and group interviews. Fieldnotes were taken after programming sessions and I also kept notes of meeting with BGC staff. Group interviews were conducted during summer sessions where youth reflected on my pedagogical practice. The criteria used to determine who would participate in the group interview was if I had taught youth in-person for at least one academic year (September - May).

Findings

The finding focuses on the period during the Covid-19 pandemic when BGC was figuring out how they wanted to proceed with STEM programming. This finding addresses the research

questions by looking at how CCW helped me to understand my own rightful presence with youth and staff. I often reduce my role to just that of the STEM educator, but during the pandemic I began to see this filtering (by the directors) of who *needs* to be here (at BGC), physically. In a time where people were placing trust above all else, to be seen as a priority to youth and staff ensured me that my presence mattered.

When the Covid-19 pandemic started programs stopped abruptly. I remember being so upset, because I finally reached a point where the Teen STEM Club participants and I were establishing a community. The youth and I had found our groove. When I showed up they knew it was STEM time and would assemble in the designated STEM area then we would get to work. I did not have to spend time trying to get them to participate because they were ready and they had developed their expectations of me. Months and months went by with the uncertainty of returning. Although the pandemic was causing a lot of changes in the rules, I was concerned with youth's perception of what I was doing. I wanted youth to know that I was trying to get back to them in any way possible. I finally received an email from the BGC Director that they wanted to move forward with programming. I was so excited to see youth via zoom that I did not think about how this new virtual platform would affect programming. Youth and I had about three sessions of very unsuccessful programming. Actually, at this point the focus was purely seeing their faces and asking how they were doing. I had thought of some digital STEM tools we could use but they faded to the background as the new focus became, "Are you okay?"

The Teen Director requested a meeting with me, which immediately made my stomach drop. I just knew she was about to cancel this program because it was not successful on this virtual platform. I feared what would be lost if we did not have STEM together because we had made so much progress in the last year. I showed up to the meeting, which included the BGC

Director, and stared at both of them, waiting for my fate. They started by acknowledging all the progress that had been made with the Teen STEM program and they were seeing lots of positive changes in the youth. I nodded my head in agreement while highlighting that the youth had worked extremely hard and I appreciated them for that. The directors looked at each other and then at me, my heart pounding as I thought, here it comes, this is how it ends for the year. In this moment I reflected on what I could have done better in a virtual setting, while fully knowing I did all that I could. The BGC Director then said, “We really don’t want to mess up the mentorship that you have established with the youth because it is very important.” The Teen Director then said, “...so basically, we wanted to ask if you were comfortable with teaching in-person because they clearly want to do STEM but the virtual part is not working.” I was so shocked at their offer because I had been so convinced programming would end that I never considered an alternative. The Teen Director added, “We are willing to accommodate you in any way, if we need to make a large shield or a plastic box for (laughing the entire time)”. I said of course I would come for them and then we discussed the details of the new Covid-19 protocols.

I knew that BGC were being very strict about who was allowed to physically be in the building with youth. Aside from staff, parents were not even allowed to go past the lobby. To be allowed to enter the building was a huge declaration that I had a rightful presence within the BGC. The BGC director was willing to disrupt the rules by extending the right to me to continue working with youth, in-person. I also highlight that when the directors were discussing why I belonged there, they used the word mentorship, not STEM. I often reduce my role to that of the STEM educator, but to be recognized for my mentorship, signaled to me that I was doing more than just STEM. This shifted my perception of what it meant to be in a community-based space

as a STEM educator. While my primary role was that of the STEM educator, the role extended way past just STEM.

Within a week we were back in-person and youth were so happy that we were back together. Youth entered the room with arms wide, ready to give me hugs and fill me in on all the *tea* I had missed. There was a moment of hesitation when they opened their arms because in these days of the pandemic touching people, outside of the ones you live with, was considered a no. Youth then looked at each other, nodded in confirmation, and proceeded to give me a group hug. I asked them what they wanted to focus on this year for STEM, considering the covid-based restraints, and they named all the activities that they enjoyed doing last year in STEM. They then settled on, “whatever you want to do Ms. Tee, we trust you.” I double-checked and said, “are you sure you want me to choose?” With the same response they nodded and said, “yep we trust you, whatever you choose will be great.” Our project became the Cal Ripken STEM challenge to develop a plane cabin prototype that addressed Covid-19 concerns.

In January 2021, the schools began to open, which caused many changes in the STEM program. Because some youth had to physically return to school, BGC has to changed the youth groups. BGC had arranged youth in “pods” of no more than ten youth and one staff member. The STEM pod was now included youth who were able to consistently come to programming. This dropped my participants from about 10 to 5, and we were placed in a different building that was adjacent to the Teen Center. Even within that building the physical location of where we gathered for STEM would change. There had also been a recent positive covid case that resulted in no STEM for two weeks. I felt like I had no control because changes were happening on a week-to-week basis and everyone had to adhere to the Covid-19 protocols to keep everyone (staff and youth) safe. I hated that I lost more youth this way but there was nothing I could do. I

began to feel even more disconnected from the youth, from the youth who were no longer in STEM, because at this point I was not even entering the Teen Center. While I was happy to keep moving forward with my core five youth, I did not want the other youth to feel that they were not chosen for STEM or that I was not thinking about them. To help with this I would visit the Teen Center, so the other youth knew I was thinking about them. I would even check in with staff about the youth and get updates that way.

Although all of this was extremely stressful to deal with, when it was time for programming I looked past it and focused on my five participants who were ready. Because we were a smaller group we were able to develop stronger connections and really came to see ourselves as our own little community. One day during programming Sa'Ryah vented about the testing schedule at her school and that it did not make sense to her. I shared that it is a crazy time and everything is very up in the air unfortunately. Sa'Ryah then looked at me and said, "Ms. Ti'Era you are the only consistent thing I have right now. Like I don't know if I'm going to school or if we'll be virtual. But I do know you will be here on Monday." I smiled and said, "Thank you, I try."

As I begin to get pulled away from youth, for reasons out of my control, I start to feel that I am being separated from my community. I initially was framing the situation as youth were the only ones who would lose something. However, when I unpack the situation more, I was afraid of the disconnect as well. Not only would I be separated from them but they would be separated from me. When Sa'Ryah shared her frustrations about the inconsistent schedule, she confirmed her expectation of me as someone who was permanent in her life. I began to realize that youth also had a permanence in my life where I had an expectation to see them as well. Youth and I

had authored this bidirectional rightful presence where we both had expectations to be in community together at least once a week and did not want it disrupted.

Discussion

Through this critical ethnography, I unpack my lived and continuing experiences with and in STEM. I wanted to understand how my CCW has helped me to establish my rightful presence as an informal STEM educator. Four themes were emergent that included; need for kinship, need for powered allies, mirroring practice, and allied political struggles.

Need for Kinship

My experiences have shown the importance of having kinship (familial capital). Kinship expands on family by including people that you feel close to and connected to. In my childhood I was shown, by my parents and family, how kinship could be leveraged to complete my school assignments. In completing the totem pole project my mother knew our limitations with aesthetics, but she did not let that stop us. She sought help for my project and did not stop until she located it. That help was found in my cousin Rabbit, and because of the kinship he did not hesitate in helping me. My childhood experience became a principle for me when I began teaching. I was aware of limitations in my pedagogical practices so I could know whom to contact to bridge those limitations. From my experience in Zaña integrating into the community was extremely crucial to my teaching. In a community with a very different background and identity from me, developing kinship was of the utmost importance. It was critical to my work because I could not rely on my language or content knowledge. With communication (English-based) and context (environmentally based degrees) being less important in Zaña, I had to work at developing relationships. This meant having lunch with families, attending religious festivals,

and participating in community events. By actively being a part of the community, I was able to develop kinship with the community, and implement my programs.

In the context of working with youth at BGC kinship shows up in two ways. The first is using my CCW to ensure youth have what they need for programming. The second is the bidirectional relationship building. Because youth and I co-create space for STEM to align with youth's ideas, this means that initially I am not aware of the vision youth have for their STEM projects. When youth explain how they envision their project, I then utilize my social and navigational capital to make sure they have the materials and resources needed. I use social capital to locate the people who may be better informed about youth's ideas. I use navigational capital to connect youth to the resources they need to support their ideas. The bidirectional relationship building strengthens familial capital with youth. This is created through being a part of the BGC community which includes, showing up for basketball games, being available to help with other non-STEM programs, and just being present in within the BGC community.

Need for Powered Allies

When I began university, I arrived with a strong understanding of how to utilize my CCW. After identifying that I was struggling with physics I knew to seek help. I went to Dr. Phan seeking support and guidance of how to navigate becoming a mechanical engineer despite my struggle with my physics course. However, Dr. Phan acted as a gatekeeper by not offering any options to support me in physics or mechanical engineering, but instead stating I change my major. The feeling of failure immediately took me back to elementary school making me feel like I was losing my title of "one of the good ones". I refused to accept Dr. Phan's "advice" and once again used my navigation capital to seek someone else. I found Dr. Simpson and in our meeting she opened up the possibilities for me to remain in STEM. Dr. Simpson provided

resources and recommendations of whom to speak with across the engineering departments. Dr. Simpson humanized me by reframing the conversation to understand my goals in STEM before she gave her suggestions. Dr. Simpson asked me what I wanted to do in STEM, and my ultimate goal was to construct things with my hands. Using this information she provided the possibilities, encouraged me to try a major that was in alignment with my interests, and kept the line of communication open by telling me to come back if that major did not work for me.

This experience highlighted the need for powerful allies as I tried to establish my rightful presence at the university. I used my navigation capital to locate a powerful ally, and while Dr. Phan was powerful, she was not an ally. My navigational capital only got me so far because Dr. Phan was not willing to engage in an allied political struggle. This, in turn, contributed to the denial of my rightful presence in the mechanical engineering program. However, Dr. Simpson extended me the right to reauthor what it meant for me to be in STEM, in ways that I had not previously considered.

Mirroring Practice

My current pedagogical practices are rooted in making youth feel humanized as they sense make what it means for them to do STEM-related work. Providing youth the opportunity to explore their ideas when problem solving leads to youth actualization of STEM practices. This is in direct parallel of how my parents would support me to problem-solve. When I was a child my mom would see me trying to figure something out and ask me questions as a means to help me think through my problem. Although my mom may have been limited on her knowledge of the activity I engaged in, it did not stop her from supporting me in the best way she knew how. She involved herself to show her support. However, my dad was more action oriented with his support. Because he had the stronger knowledge base in the mechanics of how different things

work and function, he created opportunities for me to explore making. These pedagogical practices that my parents did, helped me to know my rightful presence in making. Across all the STEM based settings I have been in, the one common thread has been if physical making was happening, I knew I had a rightful presence.

When I began teaching I mirrored the very combination of pedagogical practices that I experienced with my parents. When youth have an idea or are unsure about how to move forward, I do not immediately associate that idea with right or wrong. Instead, I ask questions so I can understand their sense making and youth have the opportunity to think through their ideas. However, I also support youth to make prototypes that mirror their ideas to provide another layer of understanding. Constructing a prototype helps youth to further think through their ideas. This mirroring of pouring out the cultural community wealth that I received from my parents onto the youth in turns nurtures my identity work as a Black STEM woman educator in the collective, intergenerational struggle for the humanizing and honoring of Black brilliance in STEM.

Allied Political Struggle

In teaching across both settings (Zaña and BGC) I have noticed that there are different combinations and kinds of allied political struggle. Depending on the decisions being made, sometimes I am the ally with power and at times I am an ally with less power. My power in both settings has looked like being the STEM expert who co-creates space for youth to have agency and choice while engaging in rigorous STEM. This means that within the boundaries of *my* program I can act as the one with power to disrupt the rules of what it means to engage in STEM-rich making. However, when we zoom out and look at the other influencing factors that impact my role, my power lessens. My role becomes nuanced because I have to rely on more

politically powerful allies to support my materials, time, space and relational resources for STEM engagement.

Going back to the conversation with the BGC directors, the nuance of my role at BGC became evident. Within the Teen Center, virtual programming was extremely difficult, prompting the BGC directors to shift to in-person programming. I did not have the power to make programming in-person automatically, I only had the power to choose if I wanted to come in-person *after* it was presented to me. However, with all the Covid-19 rules about who was even allowed access into BGC, the BGC directors became powerful allies in granting me entry. The adults who were allowed to be in the building were limited to staff only. While I am technically not a hired staff member, I am a contracted employee through my fellowship. The BGC Director exercised her power to grant me access by disrupting the technicalities of who was allowed to be in the building.

My primary takeaways from critically reflecting on what it means to be an informal STEM educator in a community-based space are that youth afford me community and my role is nuanced. I have set up this learning environment to be one where youth feel like they can author a rightful presence with and in STEM and that they can thrive in STEM. However, I had not considered what they afford me in the space, in turn. Youth afford me a community of Blackness in STEM that I rarely have the opportunity to be in. Typically, when I am in a STEM space I am surrounded by whiteness, not being able to bring all my intersecting identities. But within BGC I am surrounded by Blackness that is ready to explore and engage in STEM because we have co-created it that way. I can express myself through cultural colloquialisms (i.e. music, cultural references, African American vernacular language) that in many other settings I exist in, no one would get it. But more than that my tinkerer side gets to explore and freely think in these non-

traditional ways. I have also realized that my role is very nuanced. Officially my title reads informal STEM educator, but when I dig into what it means to be an informal STEM educator *in* a community-based space, especially when one has a rightful presence, it becomes a harder question to answer. I also contribute this tension to being heavily embedded in the space, so entrenched that I have limited view of myself. The reality is that I am many things to many people, and it honestly depends on who is asking the question.

Conclusion

I have brought many experiences with me as I have co-created this learning space with youth. I have enjoyed learning from youth as well as working alongside them to encourage their STEM-rich making. The roles of an informal STEM educator committed to the rightful presence of historically minoritized youth in STEM, can be very nuanced. We do more than only educate “content” in STEM. However, I see this as a positive to my work because my participants are not just one identity either. I conclude this autoethnography by challenging educators to look at their participants as people in their community, not just vessels to feed information to. It is important to see the multidirectional nature of communities where everyone involved is supporting each other in varied ways. I hope by sharing my own journey, it supports others to truly understand the highly rewarding yet nuanced nature of their roles as informal STEM educators.

REFERENCES

- Adams, J., Gupta, P., & Cotumaccio, A. (2014). A Museum Program Enhances Girls' STEM Interest, Motivation, and Persistence. *Afterschool Matters*, 13–20.
- Baldrige, B. J., Lamont Hill, M., & Davis, J. E. (2011). New possibilities:(Re) engaging Black male youth within community-based educational spaces. *Race Ethnicity and Education*, 14(1), 121-136.
- Baldrige, B. J., Beck, N., Medina, J. C., & Reeves, M. A. (2017). Toward a new understanding of community-based education: The role of community-based educational spaces in disrupting inequality for minoritized youth. *Review of Research in Education*, 41(1), 381-402. <https://doi.org/10.3102/0091732X16688622>
- Baldrige, B. (2018). On educational advocacy and cultural work: Situating community-based youth work [ers] in broader educational discourse. *Teachers College Record*, 120(2), 1-28.
- Bang, M., Medin, D., Washinawatok, K., Chapman, S. (2010). Innovations in Culturally Based Science Education Through Partnerships and Community. In Khine, M., & Saleh, I. (Eds.), *New Science of Learning: Cognition, Computers, and Collaboration in Education* (pp. 569–592). New York, NY: Springer. <https://doi.org/10.1007/978-1-4419-5716-0>
- Bang, M., & Vossoughi, S. (2016). Participatory Design Research and Educational Justice: Studying Learning and Relations Within Social Change Making. *Cognition and Instruction*, 34(3), 173–193. <https://doi.org/10.1080/07370008.2016.1181879>
- Barajas-López, F. & Bang, M., (2018). Indigenous Making and Sharing: Claywork in an Indigenous STEAM Program. *Equity and Excellence in Education*, 51(1), 7-20
- Bartell, T. (2011). Caring, race, culture, and power: A research synthesis toward supporting mathematics teachers in caring with awareness. *Journal of Urban Mathematics Education*, 4(1), 50–74.
- Bartolomé, L. I. (1994). Beyond the methods fetish: Toward a humanizing pedagogy. *Harvard Educational Review*, 64(2), 173–194.
- Bell, P., Lewenstein, B., Shouse, A., & Feder, M. (2009). Learning science in informal environments: People, places, and pursuits. Washington, DC: National Academies Press
- Bettez, S. C., & Hytten, K. (2013). Community Building in Social Justice Work: A Critical Approach. *Educational Studies*, 49(1), 45-66. doi:10.1080/00131946.2012.749478
- Blikstein, P., & Worsley, M. (2016). Children Are Not Hackers. *Makeology*, 64–79. <https://doi.org/10.4324/9781315726519-5>
- Boylorn, R. M., & Orbe, M. P. (2014). Critical autoethnography: Implications & Future Directions. In R.M. Boylorn and M.P. Orbe (Eds.), *Critical autoethnography: Intersecting cultural identities in everyday life* (pp. 234-238). Routledge
- Brown-Jeffy, S. & Cooper, J. (2011). Toward a Conceptual Framework of Culturally Relevant Pedagogy: An Overview of the Conceptual and Theoretical Literature. *Teacher Education Quarterly*, 38, 1-20
- CAISE. (n.d.) *What are the important gaps in informal stem education research?* <https://www.informalscience.org/research/what-important-gaps-informal-stem-education-research>

- Calabrese Barton, A., & Tan, E. (2010). We be burnin'! Agency, identity, and science learning. *The Journal of the Learning Sciences*, 19(2), 187-229
- Calabrese Barton, A., Tan, E., & Greenberg, D. (2017). The Makerspace Movement: Sites of Possibilities for Equitable Opportunities to Engage Underrepresented Youth in STEM. *Teachers College Record*, 119(7), 1–44.
- Calabrese Barton, A., & Tan, E. (2018). *STEM-rich maker learning: Designing for equity with youth of color*. New York, NY: Teachers College Press
- Calabrese Barton, A., & Tan, E. (2020). Beyond Equity as Inclusion: A Framework of “Rightful Presence” for Guiding Justice-Oriented Studies in Teaching and Learning. *Educational Researcher*. <https://doi.org/10.3102/0013189x20927363>
- Calabrese Barton, A., Kim, W. J., & Tan, E. (2020). Co-Designing for Rightful Presence in Informal Science Learning Environments. *Asia-Pacific Science Education*, 1–34. <https://doi.org/10.1163/23641177-bja10015>
- Callanan, M., Cervantes, C., & Loomis, M. (2011). Informal learning. *Wiley Interdisciplinary Reviews: Cognitive Science*, 2(6), 646–655. <https://doi.org/10.1002/wcs.143>
- Dawson, E. (2014). Equity in informal science education: developing an access and equity framework for science museums and science centres. *Studies in Science Education*, 50(2), 209–247. <https://doi.org/10.1080/03057267.2014.957558>
- Dawson, E. (2017). Social justice and out-of-school science learning: Exploring equity in science television, science clubs and maker spaces. *Science Education*, 101(4), 539–547. <https://doi.org/10.1002/sce.21288>
- Davis, N. R., Vossoughi, S., & Smith, J. F. (2020). Learning from below: A micro-ethnographic account of children's self-determination as sociopolitical and intellectual action. *Learning, Culture and Social Interaction*, 24, 100373.
- Dumas, M. J. (2016). Against the Dark: Antiracism in Education Policy and Discourse. *Theory Into Practice*, 55(1), 11–19. <https://doi.org/10.1080/00405841.2016.1116852>
- Engeström, Y. (2011). From design experiments to formative interventions. *Theory & Psychology*, 21(5), 598–628. <https://doi.org/10.1177/0959354311419252>
- Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133–156. <https://doi.org/10.1080/13639080020028747>
- Escudé, M., Rivero, E., & Montano, J. (2020). Designing for Belonging and Becoming in an Afterschool Tinkering Program. *Afterschool Matters*, 31(Spring 2020), 42–50.
- Falk, J. & Dierking, L. (2002). *Lessons without limit: how free-choice learning is transforming education*. AltaMira Press.
- Falk, J., & Dierking, L. (2010). The 95 Percent Solution. *American Scientist*, 98(6), 486–493. <https://doi.org/10.1511/2010.87.486>
- Gay, G. (2002). Preparing for Culturally Responsive Teaching. *Journal of Teacher Education*, 53(2), 106–116. <https://doi.org/10.1177/0022487102053002003>
- Glaser, B. (1992). *Emergence vs forcing : Basics of grounded theory analysis*. Mill Valley, CA: Sociology Press
- Glesne, C. (2016). *Becoming qualitative researchers: an introduction*. Pearson.
- Gonzalez, N., Moll, L. C., Tenery, M. F., Rivera, A., Rendon, P., Gonzales, R., & Amanti, C. (1995). Funds of Knowledge for Teaching in Latino Households. *Urban Education*, 29(4), 443–470. <https://doi.org/10.1177/0042085995029004005>

- Gutiérrez, K. (2008). Developing a Sociocritical Literacy in the Third Space. *Reading Research Quarterly*, 43(2), 148-164. doi:10.1598/rrq.43.2.3
- Gutiérrez, K. D., & Arzubiaga, A. (2012). An ecological and activity theoretic approach to studying diasporic and nondominant communities. In W. F. Tate IV (Ed.) *Research on schools, neighborhoods, and communities: Toward civic responsibility* (pp. 203–216). Rowman & Littlefield Publishers.
- Gutiérrez, R. (2013). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education*, 44(1), 37–68.
- Gutiérrez, K. D., & Jurow, A. S. (2016). Social Design Experiments: Toward Equity by Design. *Journal of the Learning Sciences*, 25(4), 565–598. <https://doi.org/10.1080/10508406.2016.1204548>
- Habig, B., Gupta, P., & Adams, J. (2021). Disrupting deficit narratives in informal science education: applying community cultural wealth theory to youth learning and engagement. *Cultural Studies of Science Education*, 1-40.
- Heredia, S., & Tan, E. (2020). Teaching & learning in makerspaces: equipping teachers to become justice-oriented maker-educators. *Journal of Educational Research*, <https://doi.org/10.1080/00220671.2020.1860871>
- hooks, b., (1994). *Teaching to Transgress: Education as the practice of freedom*. Routledge
- Jenkins, D.A. (2021). Unspoken Grammar of Place: Anti-Blackness as a Spatial Imaginary in Education. *Journal of School Leadership*, 3(1-2), 107-126 <https://doi.org/10.1177/1052684621992768>
- King, N., (2017) When Teachers Get It Right: Voices of Black Girls’ Informal STEM Learning Experiences. *Journal of Multicultural Affairs*, 2(1), 1-15.
- King, N., & Pringle, R. (2018). Black girls speak STEM: Counterstories of informal and formal learning experiences. *Journal of Research in Science Teaching*, 56(5), 539–569. <https://doi.org/10.1002/tea.21513>
- Kohli, R., & Solórzano, D. G. (2012). Teachers, please learn our names!: racial microaggressions and the K-12 classroom. *Race Ethnicity and Education*, 15(4), 441–462. <https://doi.org/10.1080/13613324.2012.674026>
- Ladson-Billings, G. (1995). Toward a Theory of Culturally Relevant Pedagogy. *American Educational Research Journal*, 32(3), 465–491. <https://doi.org/10.3102/00028312032003465>
- Ladson-Billings, G. (2006). From the achievement gap to the education debt: Understanding achievement in US schools. *Educational Researcher*, 35(7), 3–12.
- Love, B. (2019). *We want to do more that survive: Abolitionist teaching and the pursuit of educational freedom*. Beacon Press.
- Ma, J. Y., & Munter, C. (2014). The spatial production of learning opportunities in skateboard parks. *Mind, Culture, and Activity*, 21(3), 238-258.
- Martin, L. (2015). The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research (J-PEER)*, 5(1). <https://doi.org/10.7771/2157-9288.1099>
- Maxwell, J. A. (2012). *Qualitative research design*. Sage.
- Mensah, F. (2011). A case for culturally relevant teaching in science education and lessons learned for teacher education. *The Journal of Negro Education*, 80(3), 296-309.

- Mensah, F., & Jackson, I. (2018). Whiteness as property in science teacher education. *Teachers College Record*, 120(1), 1-38.
- Mersand, S. (2020). The State of Makerspace Research: a Review of the Literature. *TechTrends*. <https://doi.org/10.1007/s11528-020-00566-5>
- McKinney de Royston, M., Vakil, S., Nasir, N. S., Ross, K. M., Givens, J., & Holman, A. (2017). "He's more like a 'brother' than a teacher": Politicized caring in a program for African American Males. *Teachers College Record*, 119(4), 1–40.
- McKinney de Royston, M., Madkins, T. C., Givens, J. R., & Nasir, N. I. S. (2020). “I’m a Teacher, I’m Gonna Always Protect You”: Understanding Black Educators’ Protection of Black Children. *American Educational Research Journal*, 000283122092111. <https://doi.org/10.3102/0002831220921119>
- NSF. (2020, July). *NSF INCLUDES: Special Report to the Nation II: Building Connections*. <https://www.nsf.gov/pubs/2020/nsf20099/nsf20099.pdf>
- Olivares, M. C., & Tucker-Raymond, E. (2020, May 28). Critical Relationality: A Justice-Oriented Approach to Education and Education Research [2020, July 30]. https://medium.com/@mariaco_87227/critical-relationality-a-justice-oriented-approach-to-education-and-education-research-8bf911c381b4#:~:text=Critical%20relationality%20means%20we%20co,integrity%2C%20and%20protect%20your%20dignity
- Pattison, S. A., Rubin, A., Benne, M., Gontan, I., Andanen, E., Shagott, T., ... Dierking, L. D. (2018). The impact of facilitation by Museum educators on family learning at interactive Math Exhibits: A Quasi-Experimental Study. *Visitor Studies*, 21(1), 4–30. <https://doi.org/10.1080/10645578.2018.1503879>
- Peshkin, A. (1988). In Search of Subjectivity -- One’s Own, *Educational Researcher*. 17-21
- Roberts, M. (2010). Toward a theory of culturally relevant critical teacher care: African American teachers' definitions and perceptions of care for African American students. *Journal of Moral Education*, 39(4), 449-449. doi:10.1080/03057241003754922
- Rogoff, B., Callanan, M., Gutiérrez, K. D., & Erickson, F. (2016). The Organization of Informal Learning. *Review of Research in Education*, 40(1), 356–401. <https://doi.org/10.3102/0091732x16680994>
- ross, kihana M., Nasir, N. I. S., Givens, J. R., McKinney de Royston, M., Vakil, S., Madkins, T. C., & Philoxene, D. (2016). “I Do This for All of the Reasons America Doesn't Want Me To”: The Organic Pedagogies of Black Male Instructors. *Equity & Excellence in Education*, 49(1), 85–99. <https://doi.org/10.1080/10665684.2015.1122678>
- Rubel, L. H., Hall-Wieckert, M., & Lim, V. Y. (2017). Making space for place: Mapping tools and practices to teach for spatial justice. *Journal of the Learning Sciences*, 26(4), 643-687.
- Stewart, O. & Jordan, M. (2016). “Some explanation here”: a case study of learning opportunities and tensions in an informal science learning environment. *Instructional Science*, 45(2), 137–156. <https://doi.org/10.1007/s11251-016-9396-7>
- Tan, E., Calabrese Barton, A., & Benavides, A. (2019). Engineering for Sustainable Communities: Epistemic Tools in Support of Equitable and Consequential Middle School Engineering. *Science Education*, 103(4), 1011–1046. <https://doi.org/10.1002/sce.21515>

- Tan, E., & Calabrese Barton, A. (2020). Hacking a Path Into and Through STEM: Exploring How Youth Build Connecting Pathways Between STEM-Related Landscapes. *Teachers College Record*, 122(2), 1–44.
- Toyosaki, S. (2018). Toward de/postcolonial autoethnography: Critical relationality with the academic second persona. *Cultural Studies/critical Methodologies*, 18(1).
- Vakil, S., McKinney de Royston, M., Nasir, N. S., & Kirshner, B. (2016). Rethinking Race and Power in Design-Based Research: Reflections from the Field. *Cognition and Instruction*, 34(3), 194–209. <https://doi.org/10.1080/07370008.2016.1169817>
- Vakil, S., & de Royston, M. M. (2019). Exploring politicized trust in a racially diverse computer science classroom. *Race Ethnicity and Education*, 22(4), 545-567.
- Vossoughi, S., & Bevan, B. (2014). Making and tinkering : A review of the literature. In *In Commissioned by the Committee on Successful Out-of-School STEM Learning* http://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_089888.pdf
- Vossoughi, S., Hooper, P., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, 86(2), 206-232. <https://doi.org/10.17763/0017-8055.86.2.206>
- Warren, B., Vossoughi, S., Rosebery, A.S., Bang, M., Taylor, E. (2020). Multiple ways of knowing: Re-imagining disciplinary learning. In Nasir, N., Lee, C.D., Pea, R., McKinney de Royston, M. (Eds.), *Handbook of the cultural foundations of learning* (pp. 277–294). New York, NY: Routledge. <https://doi.org/10.4324/9780203774977>
- Warren, C, & Coles, J. (2020). Trading spaces: Antiblackness and reflections on Black education futures. *Equity & Excellence in Education*, 53(3), 382-398.
- Worsley, T. & Roby, R., (2021). Fostering Spaces for Black Joy in STEM-rich Making and Beyond. *Journal of Effective Teaching in Higher Education*, 4(2), 118-134
- White House. (2014, June 18). *FACT SHEET: New Commitments in Support of the President's Nation of Makers Initiative to Kick Off 2016 National Week of Making*. <https://obamawhitehouse.archives.gov/the-press-office/2016/06/17/fact-sheet-new-commitments-support-presidents-nation-makers-initiative>
- Yosso, T. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, 8(1), 69-91.
- Zavala, M. (2016). Design, Participation, and Social Change: What Design in Grassroots Spaces Can Teach Learning Scientists. *Cognition and Instruction*, 34(3), 236-249. <https://doi.org/10.1080/07370008.2016.1169818>

APPENDIX A: INTERVIEW PROTOCOL

Ms. T and her facilitation of STEM

1. What are the range of feelings that you have in working with Ms. Ti'Era?
2. What do you think Ms. Ti'Era notices about you that is different from what your science teacher notices about you?
3. Do you feel that you can be yourself during STEM with Ms. Ti'Era, and what does that look and feel like?
4. How does Ms. Ti'Era support you when you are unsure about how to do something STEM related?
 - Is this the same or different when you are at school?
5. Do you feel Ms. Ti'Era holds high expectations of you and in what ways?
6. Do you see yourself as a current and a future doer of STEM? In what ways has Ms. Ti'Era supported you to feel this way?
7. Do you feel that you can engage in STEM in different ways here?
8. In what ways do you think you are a STEM expert, give an example?

Artifact/Event focused interview

Think about your experience participating in the STEM challenge last year let's discuss your direct involvement with Ms. Ti'Era in creating the plane prototype.

1. Could you tell me about what you made and how it worked?
2. Did you feel that Ms. Ti'Era involved you throughout the process of creating your project? In what ways, can you provide an example?
3. Did you feel that she was listening to your input and implementing it? In what ways, can you provide an example?
4. Did you feel comfortable sharing your ideas with Ms. Ti'Era? What made you feel comfortable?

APPENDIX B: FIELDNOTE PROTOCOL

EC Making Grant

“Get City” [Semester, Year]

Date of Observations: [Day of Week, Month, Date]

Location: Boys and Girl Club

Fieldnotes by [Ti’Era Worsley]

Date recorded:

Photos by: Ti’Era Worsley

Those present:

Summary:

Fieldnotes: