EMBODYING UBUNTU, INVOKING SANKOFA, AND DISRUPTING WITH FELA: A CO-EXPLORATION OF SOCIAL ISSUES AND CRITICAL MATHEMATICS EDUCATION WITH SUB-SAHARAN AFRICAN YOUTH

By

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ABSTRACT

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The purpose of this qualitative research is to study if and how Sub-Saharan African youth use mathematics in understanding social issues related to the African continent. I co-explored with five Sub-Saharan African youth over the course of a semester and leaned on what Koro-Ljungberg (2012) termed methodological fluidity. I draw on decolonial theory from an African perspective (Ndlovu-Gatsheni, 2015, 2018) and African [decolonial] frameworks (Ubuntu, Sankofa, Fela Anikulapo-Kuti Music [FAM]) to center the perspectives of the colonized Other, decenter power within the research space, seek clarity on what we sought to disrupt, and find joy in the research space. Unlike previous research in this field, this study does not focus on learning new mathematics, rather, I sought to investigate what knowledges youth draw on in their exploration of these social issues.

The findings of this study highlight the focus of Sub-Saharan's youth need to re-read and re-write their African world with and without mathematics. Youth were invested in re-writing false narratives about the African continent by calling forth African Indigenous ways of knowing. This rewriting led to epistemic freedom and cognitive justice – an essential component of social justice – that redresses the loss of Indigenous knowledges. Despite this, there was still tension in both recognizing and accepting African Indigenous ways of knowing along with the belief that school mathematics is neutral.

In the final chapter, I discuss the implications of this research such as the bridging together of critical mathematics education, ethnomathematics, and Indigenous ways of knowing. I also discuss how decolonial theory and African decolonizing methodologies opened space in this research for insights that might not have been evidenced using other theories and methodologies.

To Monisola, Teniola, Adetoni, and Fiyinfoluwa.
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May you recognize the strengths and knowledges in our beloved Africa.

To my African Leadership Academy family.
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Preface: Introducing the Baobab Tree

When Soro, one of the youth I collaborated with on this project, brought up the Baobab Tree during one of our early sessions, the group lit up! Everyone had a comment to make around the importance of the Baobab tree on the African continent. Moreover, this magnificent tree is the national tree of Madagascar, Mendrika's (another youth in this project) home. The Baobab tree is commonly referred to as the tree of life given the range of resources it provides to communities, and due to its longevity. I hope that this dissertation would be life-giving and affirming to all who read it. Below, I include an excerpt from a powerful poem by the Motswana[1] poet Kenneth Maswabi (2016) as it speaks to the role of trees in African communities.

The Big African Tree

The African tree is a majestic icon
Every village is dotted with these supreme creatures
Every road side is intermittently overshadowed by these giants
Every African home has its own tree of choice

The African tree is passed from generation to generation
It is a place of rest and renewal
It holds intergenerational secrets
It's a place of family gatherings
The coldest spot on a hot summer day
It's a place for children and adults
It's also a place for justice administration or worship

The African tree is an air-conditioner of some sort
It is a board room for important meetings
It's occasionally a bedroom especially on those hot summer afternoons
It's a sitting room and a lounge
It's a classroom and an entertainment centre
It's a milling factory and sometimes a butchery
It can be turned into a makeshift garage
It's a place for everything

The African tree comes with different shapes and sizes
It's a fortress for both people and animals
It's loved for its cool shadow

[1] Motswana is a citizen from Botswana

Also, adored for its delicious fruits and nectar
Sometimes cherished for its medicinal properties
It's admired for its majestic size

The African tree is a symbol of African life
It's an icon of Africa
A revered masterpiece
Never to be cut down by men
Only destroyed by natural disasters
Or old age
It is a supreme structure
Accommodating all sorts of life
Accepting all kinds of guests

The African tree is a dying specimen
Its legacy is everlasting

I intentionally named the chapters of this dissertation using various aspects of the Baobab tree. As you read this dissertation, you will notice connections to the Baobab tree including in the fourth chapter that discusses the fruits (findings) of the Baobab tree. Below, I give a short description of my story to give you a clearer insight on my commitments to this research.

My Story

I chose to start this dissertation with a brief narrative of my story as it is important to position myself in this research. I believe this will allow you to understand the perspective I take in this research from the onset. It is important to me that you know me a little bit better before diving into this project of love. Moreover, in positioning myself in this inquiry, I adhere to Sankofa (see Chapter 1), an epistemology from the Twi people of Ghana, that stressed that we must look into our past before reflecting on the future (the rest of this dissertation).

I was born and raised in Lagos, Nigeria to two wonderful parents and have three siblings. My childhood was fairly standard in that I did not worry or want for too much. I recognized my love and penchant for mathematics in SS1 (grade 10) and began tutoring my peers. Yet I did not use mathematics to try to understand my world nor was I in any spaces where I was given a

chance to interrogate the world around me. For example, I recognized that I was the only female student in my advanced mathematics class which seemed odd to me as this was not the case in my other classes. My secondary school was located in Badagry, Lagos which was the site of the first slave trade port in Nigeria. Visiting this site was part of first year orientation but I do not remember any deep interrogation in the presentation on what slavery meant nor of the creation of the African Diaspora. I remember learning about slavery in the United States as a sort of matter-of-fact event that took place.

I moved to the United States after completing my secondary education at the age of 16. While at The University of Memphis, I was curious about the history of Black people in this country as my secondary education had not taught me. Though I was an Electrical Engineering and Mathematics major, I took courses in African American history and African American literature. There I learned in more depth about the civil rights movement and the (mis)treatment of Black people in the United States. It was also where I came to recognize anger in African Americans that I could not fully understand. In my naive view, African Americans were now free so why were they still so upset by the past? It was also there that I learned about Nikki Giovanni, Langston Hughes, James Baldwin, and many other great African American poets, writers, and orators.

In 2006, I moved to Arkansas to work as an entry level engineer and also pursued my master's degree in Applied Mathematics at the University of Central Arkansas (UCA). I was the only female, Black, and international student in my cohort. Moreover, my peers had been at UCA for their undergraduate degrees in the same program. I distinctly remember feeling like I was not accepted as an equal until we had an assignment that no one could complete but me. In many

ways, I felt that I needed to prove I belonged in that space to gain acceptance. I suddenly felt seen when others saw I could complete a task that no one else was able to do.

In 2010, I accepted the position to teach mathematics at the African Leadership Academy (ALA) in Johannesburg, South Africa. At this point, I had lived in the U.S. for eight years and was ready for a change. Moreover, unless I counted trips across the border to Benin to buy rice on my way home from boarding school, I had never visited or lived in another African country. I welcomed the chance to re-write this story. ALA changed the course of my life's journey. It was at ALA that I learned to not only love my country, but to love and embrace all of Africa because I built long-lasting relationships with people from Morocco, Uganda, Zimbabwe, South Africa, Mauritius, and Ghana, to name a few. I had never taught or worked alongside a diverse group of people from across the African continent. I did not realize how much we had in common despite our distinct differences in culture and ways of being. For instance, cultural nights were powerful as students from the same region had the task of putting on an event to showcase their region in art, spoken word, drama, dance, fashion, music, and food. I left every cultural night in awe of the beauty and magnificence of Africa and her people.

The mission of ALA is to create a generation of transformative young African leaders and I often wondered where mathematics fit in engendering this mission. I saw students having thought-provoking discussions about ways to positively impact Africa in their African studies or entrepreneurial leadership courses and wished I could do the same in my mathematics classes but I did not know how to do so. I decided graduate school was the next step for me so that I could explore how mathematics might also relate to transforming African society. This led me back to the United States where I developed clarity in my research as I sought (and continue to seek) to support all students but particularly minoritized and marginalized communities to use

mathematics (along with other knowledges) to understand social issues and to consider ways to seek justice in society.

I chose Michigan State University in part because of the legacy of the African Studies Center. I knew I could not leave ALA to return to a space where I would not be able to engage with Africans deeply about all things African. I returned to the United States as the 2016 presidential election was heating up. As it became clearer who the likely president would be, I knew I had to be in spaces that celebrated and advocated for people of color. I changed my assistantship in the spring of 2017 from a curriculum project to working with, learning from, and supporting teachers in an urban community. I created a curriculum for teachers in rural Tanzania. I became the president of the African Graduate Student Association. I tutored at the Refugee Development Center, which was comprised of mostly East African refugees in the Lansing community.

In my graduate journey, I was drawn to courses that centered people of color, such as those engaging with humanizing research and critical race theory. In mathematics education, I was enthralled by the world of teaching and learning mathematics for social justice. This world became my [academic] home. This was the world for which I had been searching. In this world, students discussed issues of (in)justice in mathematics spaces. They used mathematics to make sense of the inequalities and inequities around them. Yet much of the work I read seemed to take place in the U.S. and Europe. I began to wonder: *What did this world look like with African students? Did teachers share with students their journeys in coming to learn about and take a stand for justice? Could people use mathematics to really make sense of their realities and lives? What did it mean to use a subject that caused harm to many people to then try to validate their lived experiences? What other lenses and knowledges might be brought into the classroom,*

particularly those lenses and knowledges that are often under-appreciated or unrecognized in academic spaces?

These questions led me to my dissertation work. As I crafted the ideas for my dissertation, I took a break to attend the tenth anniversary of ALA's founding in February 2018. While there, I knew what I had to do. As early as Fall 2017, during my humanizing research course, I became invested in using theories and methods rooted in African contexts for my dissertation. I knew that I was uninterested in invoking the methods upheld by white Eurocentric men in the academy. Returning to ALA further solidified my desire to center community in my research. Hatim Eltayeb, Dean of ALA and a dear friend of mine, spoke words at the opening ceremony that reminded me that I needed to return to my light source (Eltayeb, 2018). To my people. To Africans.

I am grateful to my ancestors for Ubuntu, for Sankofa, and to Fela for giving me the words I had struggled to articulate throughout graduate school. Though none of my courses centered African scholars, I am grateful for the African scholars I was able to locate whose scholarship inspired and strengthened my work. In this dissertation, I sought to unshackle myself from colonial and western lenses as much as I could. I sought to center a group of African youth to understand their views on (in)justice and to see if these youth thought mathematics had a role to play in the quest for freedom. Thank you for coming alongside this journey with me.

Chapter 1: The Root of the Baobab Tree

"To be African, is to choose to know Africa, as you would know any community you join." (Eltayeb, 2018)

For the past three years of my graduate studies, I have engaged in research related to critical mathematics education (CME). In particular, I have focused on scholars' articulation of CME which purports that mathematics should be used as a tool to dismantle social injustices in society. Though this line of work has made important contributions to the field of mathematics education, in this study, I learned alongside five Sub-Saharan African youth to consider if and how we used mathematics in understanding, challenging, and disrupting social issues related to the African context. Standard western mathematics education in many ways has been complicit in the epistemicide (Joseph, 1987; Wandera, 2019) of local knowledges so I was intentional not to center standard school mathematics.

I chose to work with African youth because African countries, as compared to other countries, combined have the highest population of young people in the world. Specifically, "over 40% are under the age of 15 and 20% are between the ages of 15 and 24" (William, 2012, p. 30). These statistics are jarring as they mean Africa needs to prepare her young people to be integral in being positive change agents for their countries and continent largely. Thus, I have a larger goal beyond this study: I hoped that our collaboration would enable me to understand how to work with other African youth on the African continent, more broadly, and consider how to make positive social change in their communities, more specifically.

With this framing in mind, I should also stress that the co-researchers[2] and I are not a homogenous group as we all represent vastly different ethnic, language, geographic

[2] I use co-researchers intentionally to acknowledge how involved the five youth were before and during data generation of this research. Using "participant" did not feel like it did their roles justice though I also considered using "collaborators" to describe them.

characteristics, and experiences. Yet as Boutte, Johnson, and Muki (2019) point out, we have "underlying beliefs, values, norms and practices that permeate the various cultural and ethnic groups of Africa" (p. 18). Thus, we share experiences coming from colonized nations within the African continent along with a shared commitment to centering African perspectives which is the basis that guides our work together (Dei, 1994).

This dissertation project is as much a love letter to my African continent as it is a representation of my evolution in graduate school. It is a love letter in that I am rooted and guided by African frameworks (Ubuntu, Sankofa, and Fela-Anikulapo Kuti Music methodology [FAM]). These epistemological and methodological framings ground this research in a decolonizing paradigm as I am on a continual quest to elevate African Indigenous ways of knowing (Chilisa, 2011; Dei, 1994, 2002, 2012; Ndlovu-Gatsheni, 2018; Ngugi wa Thiong'o, 1986[3]) instead of centering western[4] and colonial worldviews. Like Wandera (2019), I believe "Indigenous communities have a capacity [and ability] to generate useful knowledge" (p. 1).

My decentering of western ways of knowing does not mean that I do not value these contributions or that I am choosing to essentialize African ways of knowing. Rather, I take up Bullock's (2018) statement that CME "has a commitment to … make visible what has been obscure and bring to the center what has been marginalized" (p. 123). In this dissertation, I make visible the contribution of Sub-Saharan[5] African youth in CME through theoretical and methodological lenses that have largely been invisible in CME. In the process of developing this dissertation, I was surprised – and frankly, frustrated – to discover African scholars such as those

[3] Ngugi wa Thiong'o is one name and not a first and last name in the western sense as he chose to decolonize and reject his English name by choosing a name that represents his Gikuyu culture
[4] I am intentionally using lower case for "western" to magnify Other ways of knowing
[5] I focus on sub-Sahara Africa because everyone in this research study is located in that region of the African continent

cited here had not been included in any course syllabi throughout my graduate studies. Thus, I include many African scholars to emphasize that this dissertation is deeply personal and a homage to my African continent.

In this study, I sought to invoke the pre-colonial African education that infused "notions of culture, centring[6] learners' histories, identities and experiences, and focusing on the learner's agency to bring about change in their personal and community lives" (Dei, 2012, p. 114). In addition, Ngugi wa Thiong'o (1986) stated in his foundational book, *Decolonizing the mind: The politics of language in African literature*, that education for the colonial [African] child "became a cerebral activity and not an emotionally felt experience" (Ngugi wa Thiong'o, 1986, p. 17).

To begin, I expand on the African frameworks below before delving into the purpose of this study along with the research questions I sought to answer in this study.

Guiding Frameworks

Ubuntu

Ubuntu is "borne out of the philosophy that community strength comes of community support, and that dignity and identity are achieved through mutualism, empathy, generosity and community commitment" (Swanson, 2007, p. 55). Furthermore, Ubuntu is a humanist perspective rooted in African thought that allows us to shift from *I* to *we*. Archbishop Desmond Tutu explained further in his autobiography this powerful concept of Ubuntu:

> Ubuntu is very difficult to render into a western language. It speaks of the very essence of being human. When we want to give high praise to someone we say, "Yu, u nobuntu"; Hey, so-and-so has Ubuntu. Then you are generous, you are hospitable, you are friendly and caring and compassionate. You share what you have. It is to say, "My

[6] Note that Ngugi wa Thiong'o, along with many of the African scholars cited in this dissertation, use British English in their writing because of the remnants of British colonization

> humanity is caught up, is inextricably bound up, in yours." We belong in a bundle of life. We say, "A person is a person through other persons." It is not, "I think therefore I am." It says rather: "I am human because I belong. I participate, I share." A person with Ubuntu is open and available to others, affirming of others, does not feel threatened that others are able and good, for he or she belongs in a greater whole and is diminished when others are humiliated or diminished, when others are tortured or oppressed, or treated as if they were less than who they are. (Tutu, 1999, p. 31)

Tutu's words exemplify what this project seeks to center as we worked to disrupt social issues on our African continent. Tutu counters the common referent uttered by French mathematician and philosopher, René Descartes who stated "I think, therefore I am." Instead, Ubuntu speaks to community and belonging through participation. In Ubuntu we say, I am human because I belong. An example of how Ubuntu is seen in my country, Nigeria, comes when a young person calls any adult who is in a similar age group as their parents' aunty or uncle even if there is no blood relation. I also saw Ubuntu in practice when co-researchers positioned me as a "big sister" after our initial meeting.

Connecting CME with Ubuntu in this study allowed us to focus on cultivating a space where we reflected on our shared African identity as we engaged in understanding these social issues. Ubuntu ensured that we recognized the connection between the political, cultural, social, and environmental (Swanson, 2007). Ubuntu allowed everyone to recognize that our growth and knowledge was also dependent on the support we received from those in this research space. As I will show in the fruits of the Baobab tree (findings) chapter, Ubuntu was crucial in allowing us to generate and build from what others voiced, empathize with one another during difficult

moments, and recognize that ultimately, our wellness and humanity was more important than a research project.

Sankofa

Sankofa comes from the Twi people of Ghana and roughly means "going back to retrieve what was lost" (Dei, 2012; Temple 2010; Watson & Knight-Manuel, 2017). The adinkra symbol for Sankofa is a bird looking back as shown in Figure 1.

Figure 1. Adinkra symbol for Sankofa

Invoking Sankofa in this study allowed us (myself and co-researchers) to consider our past, present, and future as we sought to disrupt social issues. In addition, it allowed us to examine what was *lost* in our prior mathematics learning as we considered studying the social issues in this study. Concurrently, Sankofa allowed us to *go back* to our various African contexts in considering, questioning, critiquing, and seeking truth that we had not had the space to consider previously.

Considering CME with African epistemologies required that we embodied Sankofa by "rethinking thinking" – a process that requires "learning to unlearn in order to re-learn" (Ndlovu-Gatsheni, 2018, p. 33). By this I mean that there was intentionality in learning about self and past

histories before we could begin disrupting social issues. These ideas are embedded in decolonizing work as "deconstruction and reconstruction" (Smith, 1999) or "rediscovery and recovery" (Laenui, 2000) and are key components of the decolonizing process. Chilisa (2012) expands on the other stages of the decolonization process to include mourning – "lamenting the continued assault" experienced, dreaming – "imaging other possibilities", commitment – "including multiple voices", and lastly, taking some form of action that is appropriate.

Fela Anikulapo-Kuti Music (FAM)

I introduce the Fela Anikulapo-Kuti Music (FAM) methodology because I saw Fela as an important, yet undervalued, voice in academic research. Using critical discourse analysis (Rogers, 2011), I analyzed Fela's (1986) song, *Teacher don't teach me nonsense,* by asking how Fela disrupts power relationships, critiques western ideals, and asks us to stop sharing *nonsense* knowledge. Fela was a political and social activist who used his music as a weapon for social change in Nigeria and arguably across the African diaspora (Hari, 2014). Fela challenged us to turn away from the white man's gaze and instead value and uphold African Indigenous knowledge (Dei, 2012; Wandera, 2019) – in this case, African epistemologies. As FAM is transposed into educational research contexts, the tenets are co-learning, disruption, and making space for joy in research. Colloquially, I called our weekly sessions along with our WhatsApp group FAM as it also speaks to family.

Co-learning. Fela began this song by asserting that teachers and students are not in the category therefore, as soon as teaching ends[7], the information will be lost. In a research context, I argue that participants might feel lost when it appears that there is a power hierarchy existing

[7] Fela's lyric explains that learning is lost because it is often imposed on students and therefore does not belong to them and is less useful to them and so they immediately let it go, it is "lost."

between both parties—teachers and students—that blurs the full understanding of the research project. Fela sang about a person always having someone in the authority role (e.g. parents, teachers, professors, employer) but this person is never allowed to share power with the person in authority. I affirm that in FAM, Fela is speaking about the importance of learning together in community. I involved co-researchers in every aspect of this study and particularly by making my own learning visible. Moreover, I ensured that in our weekly FAM sessions, we collectively constructed ideas and knowledge. I recognized the transformative characteristic of learning (Patel, 2016) and ensured that learning was a collective action in this study.

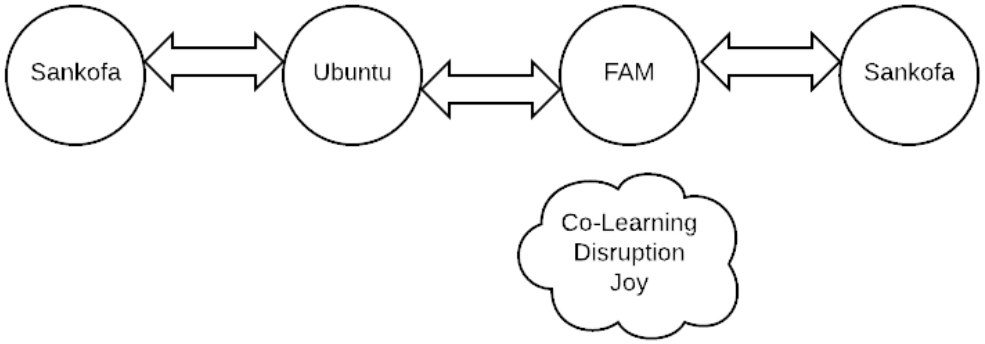
***Disruption*.** Disruption was central in this song and is a critical component of FAM. Building on my earlier explication, Fela added another layer of depth to the notion of disruption by championing the importance of naming issues. He does this by listing social issues that needed to be addressed in Nigeria at the time. These problems included inflation, corruption, and government mismanagement. Fela later problematized the need for African countries to return to their colonialists for help in solving their issues. He specifically proclaimed "let us face ourselves for Africa" which is a clear nod for centering African ways of being and knowing. Ngugi wa Thiong'o (1986), agreeing with Fela, speaks about dismantling the belief that Europe is the teacher and Africa is the student. Thus, FAM required that in this study, we were clear in stating the issues we were trying to disrupt and that we centered African epistemologies when considering the issues and their potential solutions.

Joy. The last tenet of FAM is considering how to center joy even when engaging in difficult topics in research. He beckoned that once categories cease to exist, a research space no longer becomes "you and I" but "we" invoking Ubuntu. Fela actually began this song by asking that we all sing and play music together in happiness. In addition, after Fela named some of the

many issues that needed to be disrupted, he asked “why I dey laugh (why am I laughing)?” to which he responded, “man no fit cry (man/we don’t have the energy to cry).” I argue that though Fela is not dismissing anger, he is urging us to shift beyond it and embrace the revolutionary act of using joy as a form of resistance. Joy was evident throughout as co-researchers and I recognized the Indigenous mathematics knowledges embedded in our communities that had previously not been elevated in our western forms of education.

I envisioned FAM, Ubuntu, and Sankofa as interconnected as shown in Figure 2 below. I intentionally use circles to show the importance of co-learning and community. I also staggered the arrow to show the necessity of disruption. I include Sankofa in the front and back to indicate the back and forth movement within Sankofa.

Figure 2. Relationship between African frameworks



At the heart of the three frameworks is the importance of centering local knowledge in the research space. Ubuntu and FAM are linked in that both frameworks emphasize co-learning and humanizing the other; FAM and Sankofa both affirm disruption (the arrows are staggered to show this disruption) which comes from naming issues and considering the past in order to move forward. It is necessary to note that Sankofa, Ubuntu, and FAM moved across all aspects of this research in implicit and explicit ways. Sankofa is foregrounded because of the intentionality in

reflecting on the past as we considered the future. Ubuntu and the co-learning component of FAM is also salient across the project as this was the ethos that guided this study. In my findings chapter, I am explicit in calling out the different frameworks where they arise, but it is necessary to clarify that each of these frameworks was a core aspect of this research. Drawing on FAM allowed me to center joy in this research and to enable myself and youth co-researchers to make this research an *emotionally felt* space. Both Dei (2012) and Ngugi wa Thiong'o (1986) opine that education for an African child should be one that involves the whole being and it is this framing with which I situate this study.

My Entry into CME

In this section, I discuss the soils and nutrients that have anchored my roots in CME and have enabled my growth and trajectory in this research.

In my practicum[8] study, I investigated how a mathematics teacher conceptualizes, plans, and executes teaching mathematics for social justice (TMSJ). As I discuss later, I consider TMSJ to be related to the branch of CME that considers how to specifically use mathematics to understand and take action on a social issue in a local or broader community. I wanted to understand what sources Ms. Tara (pseudonym) drew upon to inform her course, how she embedded student's voices, and how students took up and were shaped by these topics. Ms. Tara was a white woman in her early thirties teaching in an urban district. The majority of her students were students of color. She taught in a project-based-school-within-a-school and was invested in using projects that allowed her students to delve into social (in)justice in their community. My rationale for this practicum study was to understand how Ms. Tara planned her course given that common critiques of CME confirms an inherent difficulty in planning for appropriate contexts

[8] A required small-scale research study conducted in my second year of graduate studies. Similar to a dissertation, this study involved writing a proposal, collecting and analyzing data, and defending the study to a committee.

(Brantlinger, 2013; Gonzalez, 2009; Gutstein, 2003, 2016). My extensive reading of this research suggested to me that, to make CME more authentic to students, it would be imperative that their voices be present particularly in the planning phases (Gutstein, 2016).

Ms. Tara chose a project that required students to investigate whether the wheelchair ramps in their school were compliant with the Americans with Disabilities Act (ADA). After observing Ms. Tara during the course of the project that spanned three weeks, however, I found that students had not had any input into the focus or design of the project. Furthermore, she had used this context multiple times, and already knew that the ramps in the school were indeed compliant with the ADA. This made me wonder about the role of not only student learning but also teacher learning in CME. In addition, I found that the social issue of focus (physical accessibility to the school for people in wheelchairs) quickly took a backseat to the mathematics goals. This is not a critique of Ms. Tara; it is, however, it is a challenge of this kind of teaching and learning that many scholars have lamented (Bartell, 2013; Brantlinger, 2013; Gutstein, 2003; Raygoza, 2016; Turner, Gutierrez, Simic-Muller, & Diez-Palomar, 2009).

Ms. Tara also faced discomfort in informing students that an important goal for her was fostering a space for them to use mathematics to understand issues of (in)justice. In a follow-up interview, I asked her why she felt uneasy, and her response was that "I don't want to use those words because I want it to be inherent. I don't want the kids to feel like I am pushing my own social agenda down their throats." Gutstein (2016) notably concluded that the purpose of CME was "to prepare students to transform an unjust reality, with and without mathematics, as they see fit" (p. 488). The lack of authenticity, the tension between the social issue and mathematics, along with Ms. Tara's discomfort in stating her goals explicitly to her students, however, created a barrier to the goals of CME.

An important and overarching critique that scholars have made about CME is that CME attempts to exist in a schooling structure focused on capitalist ideals and not on critical consciousness (Jurdak, 2016; Pais, 2013; Pais, Fernandes, Matos, & Alves, 2012). That is, CME is trying to work in a colonized system or in the Eurocentricity of mathematics or education broadly (Fasheh, 2012; Joseph, 1987; Ngugi wa Thiong'o, 1986; Tate, 1995). Other concerns raised about CME include the lack of rigorous mathematics involved (Brantlinger, 2013; Gutierrez, 2009; Raygoza, 2016; Turner et al., 2009), the lack of time to explore social issues deeply (Bartell, 2013; Brantlinger, 2013; Brelias, 2015; Turner et al., 2009), the lack of cross-disciplinary exploration (Dias & Gonçalves, 2016; Gutstein, 2016; Raygoza, 2016; Skovsmose, 1994; Tanase & Lucey, 2015), and lastly, how critical mathematics may take time away from the dominant mathematics students are accountable for in this era of testing (Brantlinger, 2013). This set of concerns leads me to the purpose of this dissertation project, which is the focus of the next section.

Statement of Purpose

Building from the introduction, I wondered what it would look like *not* to assume that mathematics can be used as a tool to understand social injustices. Perhaps, instead, mathematics might be just one tool people can use, but can be quite incomplete in itself (Bullock, 2018). I decided to co-explore this notion with a group of Sub-Saharan African youth. Moreover, many of the concerns mentioned earlier (e.g. Bartell, 2013; Brantlinger, 2013; Gutstein, 2016) are related to doing CME in a formal mathematics classroom. Thus, my dissertation will add a needed nuance missing in CME by showing how CME might be understood in a context where the primary focus was not to learn new school mathematics. By this I mean that this space was not a mathematics class or an after-school mathematics club, as is often the case. In addition, there is a

silence of African youth in existing mathematics education research (Osibodu & Cosby, 2018) and particularly under the umbrella of CME. Thus, the purpose of this dissertation is to *co-explore*, with Sub-Saharan African youth, if and how we use mathematics in understanding, challenging, and disrupting social issues. I further investigated how decolonial theory, decolonizing methodologies, and the African frameworks (Ubuntu, Sankofa, and FAM) enabled deep insights for me as I answered my research questions, but that also created possibilities for interrogating the connection between CME, ethnomathematics, and Indigenous ways of knowing for Sub-Saharan African youth. To set the stage further, I explain some key terms as I use them in this dissertation at this time.

I use "co-exploration" as learning in community is a critical component of African epistemologies. Thus, I planned to be a part of this exploration with co-researchers. "Disrupting" is a key component of a decolonizing lens, though what it means to disrupt can take multiple meanings. In this study, I consider disruption to be happening as we conduct our exploration of these social issues because the act of making sense of our experience, as well as naming and envisioning solutions, is an active disruption of the status quo. I also consider the sharing of our findings useful as a tool of disruption as it offers an alternative narrative to traditional pedagogies, and is responsive to the community it engages, especially within a decolonizing frame. Lastly, I define "social issues" as issues of injustice that impact a substantial group of people, and the process of exploration is nuanced and complex. For instance, in my initial meeting with co-researchers, they raised two issues: educating the girl child in Africa, and a lack of agricultural understanding amongst youth on the continent. Both of these issues, I argue, cannot be explored simply using a mathematical lens.

In this study, I position the Sub-Saharan African youth as co-researchers and not simply participants. I further explain this stance in Chapter 3. The co-researchers who journeyed with me in this dissertation study are youth[9] who are currently in their second year of university studies in the U.S. Home to them and for me is still our country of origin or another African country, as I mentioned in the introduction. In the summer following this research project (summer 2019), they all returned to their respective countries for internships as required by their scholarship program. I also spent six weeks during that same period co-leading an education abroad in South Africa. Cesar Chavez (1984) stated aptly, "once social change begins, it cannot be reversed. You cannot un-educate the person who has learned to read." Therefore, I hoped that we would continue to remain in conversation about the work we did together while reflecting on what we noticed as we returned to the African continent.

Research Questions

The research questions that guided this study are:

1. What knowledges do Sub-Saharan African youth draw upon in their investigation of social issues? How might these knowledges advance our understanding of CME?
2. When and how do Sub-Saharan African youth draw on mathematics, broadly, to understand and to disrupt social issues? How do they view the role of mathematics in disrupting these social issues?
3. What affordances does an African epistemological grounding have as youth and I engage in the research process?

[9] I refer to co-researchers as youth and not students because positioning them as students implies that I am their teacher – a dichotomy I did my best to disrupt. Moreover, the African Union (2006) defines youth as those ranging from 15-35 and all five co-researchers fit the classification as youth in the African context. This is also because African society structures impedes young people from being classified as "adults" in a way the U.S. for example does. Youth do not own cars at the age of 18 or move out of their parents homes should they choose.

I explored these questions over a 12-week long semester with five Sub-Saharan African youth whom I met with weekly for approximately two hours each session. I drew on decolonial theory and decolonizing methodologies while adhering to methodological fluidity (Koro-Ljungberg, 2012) as we collectively generated data that informed this study.

Overview of Chapters

The remainder of this dissertation spans four chapters where I further explore the foundations of CME, theoretical and methodological approaches undergirding this research, and the social issue exploration between the five youth co-researchers and me. Below I give a brief description of the function of each of these remaining chapters.

Chapter Two: The Seeds of the Baobab Tree

Before a tree can grow, seeds have to be geminated. Chapter two, like a seed, contains the literature review of this study. I begin by giving an overview of Sub-Saharan African education and what it would mean to decolonize this education. Then I discuss CME beginning with its progenitors and expand on how CME has been conducted in contemporary research. Next, I review the literature of ethnomathematics and Indigenous ways of knowing and argue for what these bodies of work might offer CME in pushing the mission forward. Lastly, I bring CME in conversation with decolonizing education by articulating what decolonial theory has to offer.

Chapter Three: Planting the Baobab Tree

In chapter three of this study, I use the metaphor of planting the Baobab tree as I link decolonial theory and that African frameworks that guide this study with the specific methods involved in generating data. I also give a description of my analysis and how it helps me answer my research questions. Particularly, I discuss how Indigenous methodologies helped me navigate

ways to tell stories and make sense of these stories in ways that honored co-researchers. connects with my guiding frameworks.

Chapter Four: The Fruits of the Baobab Tree

After the Baobab tree has been planted, it bears fruits. In Chapter four, I provide the findings of this study in six sections. In the first three sections, I begin by overlaying the narratives of the youth to describe collective experiences further adhering to Ubuntu and co-learning in this study. In these findings' sections, youth and I engage with Sankofa by exploring our previous education experiences. Through these stories, I analyze the impact of colonization, broader sociohistorical and sociopolitical knowledge, along with elder knowledge in youth's re-writing of Africa narratives. I further offer that the centering of decolonial theory and African frameworks allowed the youth to become aware of multiple ways of knowing. In the fourth and fifth sections of the findings chapter, I describe the participatory action research we conducted and how the process informed youth's view of the role of CME in African contexts. I show how youth shift from an awareness of multiple ways of knowing to valuing these ways, particularly African Indigenous ways of knowing, in mathematics learning. While youth use statistical data in investigating a particular social issue, their broader focus and commitment was to elevate the role of African Indigenous ways of knowing within and out of mathematics. In the sixth section, I engage in Sankofa by reflecting on my role and learning within the study.

Chapter Five: Lasting Legacy of the Baobab Tree

In the final chapter of this dissertation, I summarize the findings generated through this process and share learnings from decolonial theory, Ubuntu, Sankofa, and FAM. Next I bridge together CME, ethnomathematics, and Indigenous ways of knowing. Lastly, I return to the need

to decolonize Sub-Saharan African education, discuss my wonderings, and considerations for future research.

Chapter 2: The Seeds of the Baobab Tree

"But Africa is not a problem. Nor is it an opportunity. Africa is a community of persons."
(Eltayeb, 2018)

I begin this literature review by sowing seeds about the history of Sub-Saharan African education and connect this with decolonization. Then I bring these ideas in conversation with CME by discussing how my research addresses a gap in the CME landscape. Lastly, I describe decolonial theory that foregrounds this study.

Sub-Saharan African Education

Given that this study is focused on African youth, it is necessary to give context to the historic and current state of [colonial] Black[10] education broadly and Sub-Saharan African education specifically. Black education has historically been subservient to the white counterpart (Abdi, 2002; Fanon, 1961/1963; King, 2005; Wynter, 1968/1969). Moreover, Black education has been – and I would argue continues to be – anti-Black and violent. This reality has been in existence since African people were stolen and brought to the Americas, England, France, Portugal, and other colonizing nations. Sylvia Wynter (2003), writing in her powerful and foundational piece, *Unsettling the Coloniality of Being/Power/Truth/Freedom: Towards the Human, After Man, Its Overrepresentation--An Argument* noted that Black African descendants were "constructed as the ultimate referent of the 'racially inferior'" (p. 267).

In the African context, Wane (2009) holds that "colonial education has never been inclusive" (p. 161) and this type of education still dominates the landscape. Moreover, colonial education further went on to intentionally devalue and distort pre-colonial education (Fanon, 1961/1963; Ngugi wa Thiong'o, 1986; Nyamnjoh, 2012). Colonial education presumed that the

[10] I use Black to encompass all Black people whose ancestors were stolen from the African continent and who now encompass the Black diaspora.

unfamiliarity and strangeness of Indigenous peoples[11] ways of knowing meant that they were "demonized" and thus, needed to be cured through Christianity (Abdi, 2002; Mignolo, 2007, Wynter, 2003). Thus, the introduction of western education was to cultivate an African class that modeled systematically around Christian values (Ohuche, 1978). Schutte (1995 as cited in Abdi, 2002) noted the following themes in secondary school textbooks:

> Whites are superior; blacks are inferior.
>
> The Afrikaner has a special relationship with God.
>
> South Africa is militarily ingenious and stronger.
>
> The Afrikaner has a God-given task in Africa. (p. 112)

Shown once more is the way white colonial powers have used Christianity to devalue Black people, a practice that continues across the world today. Zooming in on Apartheid South Africa for example, the Afrikaner distinguished the school curriculum by introducing Bantu education for the Black populace. Bantu education was intended to provide just enough education to Black people that would allow them to take on menial jobs, but one that would maintain the unequal distribution of knowledge (Abdi, 2002). What made Apartheid so prosperous "was because it was structured within the education system" (personal communication with Dr. Nomalanga Grootboom, May 19, 2019). Zooming out, the colonial structures of education were dissimilar to pre-colonial African education that emphasized community (Ngugi wa Thiong'o, 1986). Moreover, though pre-colonial African education was not characterized as formal education in the western frame of thinking, Abdi (2002) urgently put forth:

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[11] I use "peoples" to denote the multiplicity within Indigenous communities

> It is undoubtedly true that European-style systems of education were not available in precolonial South Africa. What that should not represent for either historical or analytical purposes is that Indigenous African systems of learning were not culturally legitimate, or worse, were not educational at all. (p. 12)

Abdi notes here that pre-colonial African communities had systems before colonization that allowed societies to survive and thrive. African societies built homes, cured diseases in humans and livestock, made beautiful art and passed on knowledge from elders to the younger population. This Indigenous knowledge base was devalued and stunted due to the infestation of colonial powers. African and Africanist scholars, howver, are on a quest to reintroduce these African Indigenous knowledges back to African communities in a deliberate act of decolonization (Boutte, Johnson, & Muki, 2019).

Although African scholars are rarely, if ever, included in western scholarship or critical pedagogy/education research, a focus on reading and writing their [African] world has been a focus of prominent African scholars for many years. Julius Nyerere (1967), former Tanzanian president and anti-colonial activist, spoke about the need for Tanzanian society (and largely African society) to shift away from the colonial system of education. To Nyerere, colonial education emphasized the type of banking education Freire (1970) discussed where it is assumed that education is akin to depositing knowledge in students. Also, Nyerere pointed out that colonial education was elitist, did not allow schools to be an inherent part of society, emphasized knowledge obtained only from books and not from members of society who did not receive a "formal" education, and expected individuals to show "subservient attitudes" (1967).

These attributes of colonial education relate to Ngugi wa Thiong'o words mentioned earlier where he maintains that colonial education was cerebral, and the African child was

stripped away from an emotional and spiritual educational experience. Nyerere (1967) further spoke about colonial education motivating inequality as it positioned strong people against weaker people thus anti-colonial education needs to emphasize Pan-Africanism (i.e., African unity) as a goal, rather than the notion of ranking and ordering people apparent in colonialism. Nyerere (1967) stressed that education must allow people to "think for themselves" and "to make judgements on all the issues affecting them," must emphasize the "we" in learning and not the "I," and knowledge should be sought out not only in books but also from film, radio, the elderly, "discussions about matters that affect our lives," and broadly from the community. Diversifying the types of knowledge we elevate is in itself a decolonizing act (Ndlovu-Gatsheni, 2018). It is precisely this attitude that incited Steve Biko, South African anti-apartheid activist, to write about Black consciousness as a force to not only counter apartheid, but to reclaim self (Biko, 1977).

At the core of Black consciousness is liberation not for the oppressor, but for the Black oppressed. Biko (1977) defines Black consciousness as,

> the realization by the Black man of the need to rally together with his brothers around the cause of their oppression - the blackness of their skin - and to operate as a group in order to rid themselves of the shackles that bind them to perpetual servitude. (p. 6)

Similar to Nyerere, Biko was unabashed in his view that Black people had to free themselves of the mental enslavement that caused them to accept the notion that they were beneath their oppressor. Ngugi wa Thiong'o (1986) expressed this accurately in stating that colonial education caused the child to "stand outside himself to look at himself" because of the child's inculcation in a history that was not his (p. 17). To counter this, Biko argues that critical pedagogy should

then emphasize a correction of false histories and narratives told to the African child. As Frantz Fanon (1961) offers,

> Colonialism is not satisfied merely with hiding a people in its grip and emptying the native's brain of all form and content. By a kind of perverted logic, it turns to the past of the oppressed people, and distorts, disfigures and destroys it. (p. 200)

This quote exemplifies the need for critical pedagogy to include not only a *revisiting*, but a *rewriting* of the past to include the voice of African elders, thinkers, and scholars.

I recognize that CME is not a concept that originated from an African scholar; thus, we must interrogate and theorize if and how it applies to an African context, recognizing that "concepts come with their own cultural and philosophical baggage" (Oyewunmi, 1997, xi). I will show how CME, as it is currently constructed, does not push the needle enough in interrogating the past, present, and future baggage of colonization concerning Sub-Saharan Africans.

Decolonizing African Education

In discussing decolonization, I am intentional in situating literature from an African context. Decolonization has often focused on Indigenous communities that continue to exist despite the historical and continual push from white settler colonialists to eradicate their very existence. Wane (2009) asserted that "decolonization may mean questioning one's education and the acquisition of knowledge, what is learned in schools, who writes history, whose story is legitimized, and how power plays a role in the production of knowledge" (p. 171). Thus, decolonization is both an individual exercise as one question the colonial/western knowledge that one has been embroiled within and also a process of challenging the systemic functioning of this same knowledge that has permeated African institutions largely. Because as Wynter (2003) contests that "one cannot 'unsettle' the 'coloniality of power' without a redescription of the

human outside the terms of our present descriptive statement of the human" (p. 268). It is this *redescription* that decolonization seeks particularly in redressing the disruption and alienation of African Indigenous knowledges.

African scholars have written about the violence in the curriculum that was built from the pre-colonial forms of education which removed the connection before one's community and school (Dei, 2012; Ngugi wa Thiong'o, 1986; Wane, 2009). Thus, there is urgency in reclaiming African ways of knowing that are liberatory and transformational. Dei (2012) conceives of African Indigenous knowledges as:

> Interrogation, validation and dissemination [including teaching and learning] which utilizes what was available, what people know and sought to know, how African learners come to understand and interpret their worlds (social, physical and metaphysical) and acted within such worlds for effective social existence. Such education is a teaching and learning about the past, present and future continuum that emphasizes the place of local culture, traditions and history. (p. 112)

Thus, African Indigenous knowledges locates local knowledges as the source while imbuing a sense of criticality as well. Additionally, African Indigenous knowledges includes a connection to the spiritual (ancestral) realm along with a valuing of the past.

Many scholars have spoken about the importance of an education that is culturally relevant (Ladson-Billing, 1995) and culturally sustaining (Paris, 2012) as this allows for wholeness and the liberation of self and communities from the ill of Eurocentric, colonial education. Yielding Dei's (2012) call, I, as an African educator, sought (in this dissertation) and I continually seek to center the histories, strengths, and struggles of Africans towards a decolonized education system. Next, I review CME research and then bridge this review with

Sub-Saharan [decolonizing] African education to argue for the need to interrogate CME within a decolonizing lens particularly with Sub-Saharan African youth.

Critical Mathematics Education (CME)

The growing political and social justice foci in society and in education has allowed CME to cover a growing landscape in mathematics education research. CME traces its roots to critical pedagogy—which I discuss in the next section—with two of its originators being Danish scholar, Ole Skovsmose (1994) and U.S. scholar Marilyn Frankenstein (1983). In Eric 'Rico' Gutstein's (2016) article, he equated CME's conception outside the United States and in the United States by stating that "although multiple interpretations exist for these terms, U.S. educators mainly refer to "mathematics for social justice," and those in other countries refer to "critical mathematics," often with roughly the same meaning" (Gutstein, 2016, p. 455). Common across these perspectives is the purposeful role of CME in research, teaching, and teacher education in proffering possibilities of mathematics as a tool toward social change.

In reviewing relevant literature related to this dissertation, I first provide a brief overview of critical pedagogy as it is the foundation upon which CME stands. Then I return to the contributions made by the two foundational scholars of CME referenced earlier before synthesizing current literature to show the type of work and context often involved in CME. I will show the depth and breadth of studies conducted within CME to postulate that taking on a decolonizing theoretical framing could provide a different lens to how CME is presently conceived. I further explore ethnomathematics and Indigenous ways of knowing in mathematics education research as the findings of this research show the interrelatedness between CME and ethnomathematics when using a decolonizing lens. I end by introducing decolonial theory, which undergirds this study.

Critical Pedagogy

According to Wager and Stinson (2012), critical pedagogy evolved from critical theory and can be traced at least back to the scholars at the Frankfurt School (circa 1920) which, based on Marxism, held a view that one must critique the social structures and ideologies using a sociopolitical lens. Paulo Freire, a Brazilian educator whose prominent books and writings have largely influenced many of the scholars referenced in this literature review, built on critical theory and developed important ideas largely focused on literacy in relationship to people who were marginalized and oppressed in society. One of the important ideas from his two of his influential books *Pedagogy of the Oppressed* (Freire, 1970/2000) and *Education for Critical Consciousness* (Freire, 1973) is *conscientização*. Conscientização translates to raising the consciousness of both the oppressed and the oppressor to be free from the systems of oppression they live within or in Freire's (1970/2000) words, "learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality" (p. 35). Both books have at their core the need for the oppressed to be aware of their oppression and to take action in freeing themselves of this oppression. Freire and Macedo (2005) argued that literacy was not only an important skill that was needed for individuals, specifically to be able to read and write (*read and write the word)*, but that literacy was needed to allow them to critically analyze society (*read and write their world)*.

Examining the Progenitors of CME: Frankenstein and Skovsmose

Focusing on CME, it is important to contextualize this work by beginning with the two scholars that are credited with coining CME. In her foundational paper, Frankenstein (1983) presented a theory of CME modeled on Freire's *Pedagogy of the Oppressed* book. After laying out Freire's theory, she stated the need for a mathematics education that advocates for social

change and liberation. Frankenstein also used examples from her teaching experience with working-class adult learners, many of whom were women and people of color, in making her case. In addition, her students were committed to working in "public or community service" (p. 336). In this piece Frankenstein put forth that mathematics education "supports hegemonic ideologies" and that CME can "develop critical education and lead to critical action" (p. 327). Unpacking the statement, Frankenstein decried the dominant powers in society who set systems that historically and presently marginalized many in society. For Frankenstein, mathematical knowledge, particularly statistical literacy, is an important tool to leverage in CME. Frankenstein (1983) explicitly confirms that she was coming from a Freirean perspective; therefore, a major goal for CME is that it should enlighten, emancipate, and offer people the tools to make social change. Frankenstein (2001) later renamed CME as criticalmathematics literacy where she re-examined the goals for CME. In critical mathematics literacy, she argued, students need to:

- understand basic mathematics
- understand the mathematics used in making political decisions
- understand how mathematical knowledge is politicized (e.g. the inaccuracy of the area of countries in world maps that depict Europe as larger than Africa)
- understand that knowledge (particularly mathematics) is inherently political (e.g. how Black and white students are viewed differently in the context of mathematics). (p. 53)

To challenge these hegemonic ideologies, she contended, students need to learn to take action for social change, through a dialectic engagement with teachers using mathematics. For students to develop critical consciousness about their world, they must not only rely on mathematics knowledge but also must develop an understanding of the sociopolitical implications of this knowledge. Here, Frankenstein sees mathematics, and in particular, statistics,

as a tool that can be used not only to challenge and expose, but also to transform. Related to what it means to transform, Dei (2012) argues that it is not enough to understand the complexities of social issues but to seek to "subvert and decentre power" (p. 112) which I expound upon shortly.

Frankenstein gave examples of the types of questions that could be posed to students in CME contexts. These included critiquing the U.S. federal budget and military spending, and using data on the median income of Black and white families to discuss racism in the United States. As she stated, "critical mathematics education can challenge students to question these hegemonic ideologies by using statistics to reveal the contradictions (and lies) underneath the surface of these ideologies by providing learning experiences where students and teachers are co-investigators" (p. 329). For Frankenstein, upon reflecting and discussing these issues in mathematics classes, students could then show their commitment to action by joining local groups in the community focused on enacting social change.

Almost a decade after Frankenstein published this article, Ole Skovsmose (1994), published his book *Towards a Philosophy of Critical Mathematics Education*. Though Skovsmose mentioned Frankenstein's work on CME, he did not build on her work. Skovsmose's view of CME stemmed primarily from the Frankfurt school's framing of critical pedagogy. In his book, Skovsmose presented a theoretical representation of CME where he asserted that CME be defined in terms of its concerns, including inequalities, social justice, student and teacher autonomy, and socio-economic functions of mathematics and mathematics education (Skovsmose, 1994, 2011). For Skovsmose, these concerns need to be broadly defined or, as he contends, "open" because of the varied sociopolitical issues that could exist in different contexts. Skovsmose (1994) proposed three knowledge bases that CME provides: *mathematical knowledge* which refers to the dominant mathematics understanding upheld in society;

technological knowledge which refers to the ability to apply mathematics particularly in employing technology given that we live in a highly technological society; and *reflective knowledge* which refers to reflecting on the uses of mathematics and technology in society.

In theorizing CME, Skovsmose wondered if a notion of 'mathemacy' akin to Freire's literacy could be envisioned. Acknowledging that mathematics does indeed have formatting power (i.e., it is not neutral), Skovsmose used examples from projects conducted with elementary school students in Denmark to determine if mathemacy could be used as a form of empowerment. An example he gave of such a project was the Family Support in a Micro-Society, which tackled child benefit support for various types of families in Denmark. In this project, students were tasked with creating an algorithm to determine what factors would impact how their districts should award child benefit support to families. Skovsmose asserted that, indeed, mathemacy could be leveraged as a way "to interpret and to understand features of our social reality" (p. 208). Skovsmose (2011) built on his notion of mathemacy indicating that it should "ensure social response-ability for marginalised groups of students" (p. 86). By response-ability, Skovsmose, contended that mathemacy should enable students to respond to any situation they find themselves though the form of response was not specified.

Across Skovsmose and Frankenstein, I have shown how CME was originally conceptualized. Across both progenitors, I am noting that they are both drawing primarily from the type of mathematics purely taught in schools. That is, they are not bringing to bare other types of knowledges that also are important when understanding social issues. Building on these progenitors, I reviewed literature to examine the types of studies frequently conducted in CME and to situate this dissertation.

CME in Contemporary Times

Upon reviewing CME research from the last two decades, I noticed key similarities amongst the types of studies conducted. Before delving into these studies, it is important to note that critical mathematics educators involve scholars who consider equity, access, and power in their work. These scholars examine sociocultural and sociopolitical factors that impact mathematics learning in all its forms. In this study though, I use CME to mean scholars who engage students directly and report on student engagement in considering ways to use mathematics to understand issues often beyond the classroom. Thus, I am using CME to mean an area of work in which scholars identify closely with Frankenstein and Skovsmose's interpretations.

A notable scholar in contemporary times is Gutstein (2003, 2007, 2016), whose work has been the foundation for others. Gutstein (2007) introduced a framework for CME called the three C's (community knowledge, critical knowledge, and classical knowledge). By community knowledge, Gutstein referred to the cultural knowledge students and teachers bring to the classroom. Critical knowledge is the "knowledge about the sociopolitical conditions of one's immediate and broader existence" (p. 110), while classical knowledge refers to the dominant mathematics knowledge that is often valued in schools - that is, the "formal, in-school, abstract knowledge" (p. 111). I note here that Gutstein expands on the types of knowledge that are needed in redressing social issues. Though Gutstein references community knowledge as cultural knowledge, there has been a separation between CME, ethnomathematics, and Indigenous ways of knowing. As his work has been taken up by many researchers, I am drawn also to the types of participant population and research methods that is often taken up in CME to show the gap that this research study fills.

Participant Population. First of all, CME has been conducted mostly with a school-age population ranging from elementary (e.g., Turner et al., 2009; Varley Gutierrez, 2009; Vithal, 2003), and middle school (e.g., Gutstein, 2003), to high school students (e.g., Brantlinger, 2007; Brelias, 2015; Gregson, 2013; Gutstein, 2003, 2006, 2016). For most of the scholarship that is accessible, this work has largely been conducted in the United States (e.g., Oh & Kwon, 2015; Wright, 2015). Although there have been a few outliers (e.g., Le Roux, 2016; Vithal, 2003, 2012), the bulk of studies related to students in which social justice is named in their conception of CME have been conducted in this context (e.g., Brantlinger, 2007, 2011, 2013, 2014; Brelias, 2015; Esmonde, 2014; Gutstein, 2003, 2007, 2012, 2016; Raygoza, 2016; Turner, Gutiérrez, Simic-Muller, & Díez-Palomar, 2009). Particularly, these studies have often focused on either a minoritized community such as a predominantly African American or Latinx populations or a low-income population which often overlaps with the prior demographic. In rare instances, such as in Esmonde (2014) and Kokka (2017), CME was conducted with an affluent community.

In most of the studies cited above, students were in a formal mathematics class or preparing to teach mathematics in a formal setting, with a few exceptions (Turner et al., 2009; Varley Gutierrez, 2009). Turner and colleague's study was in an out-of-school mathematics club for elementary students. Given that a central goal for CME is ultimately to "prepare [students] to critically investigate, challenge, and act on issues in their lives and communities" (Turner et al., 2009, p. 137), we need to understand how CME functions with populations who are not in formal or informal mathematics learning spaces.

Participatory approaches in CME. In CME studies, rarely do we see instances of the teacher-researcher (as is often the role) discussing *with* students about their own learning of issues of injustice. This kind of discussion does appear in other bodies of work like literacy

education. Valerie Kinloch's (Kinloch & San Pedro, 2014) project, for example, examined youth's experiences with gentrification, race, and literacy. A young person in her study, Phil, asked Kinloch about her thoughts on gentrification in Harlem to which she responded, "you don't know what I think?" (Kinloch & San Pedro, 2014, p. 37). Phil's immediate response was "I know what you think about it, but I'd like to hear you say it. Put words to it." Phil sought to break down the power structures that were in place wherein Kinloch asked questions and Phil (along with other youth in the project) provided answers.

Gutstein (2016) stated that in CME, it is needed for "teachers and teacher educators [to] cultivate critical knowledge, sociopolitical consciousness, and dispositions. If we want students… to develop critical perspectives on reality, we have to do the same" (p. 491). In his study, he showed his learning in the moment when he embarked on a project with a student around housing displacement and gentrification. He wrote,

> comprehending how and why it was occurring and its relationship to students' lives and neighborhoods required me to study and understand the interconnections of local and global phenomena. A student and I researched the project, and he shared his analysis in class and at the community presentations. (Gutstein, 2016, p. 492)

Gutstein engaged in a participatory approach (Cammarota & Fine, 2008; Irizarry, 2009; Irizarry & Brown, 2014) in his study because CME, like other forms of potentially decolonizing pedagogy and research, should be relational (Chilisa, 2011; Patel, 2015). In CME, we need to foreground that "teachers and students need to learn—together— how to navigate change" (Gutstein, 2016, p. 487) in participatory and relational ways. For this to happen, exploring authentic issues is paramount because if, like Ms. Tara, we investigate issues that we already know the answers to, it is difficult to show your learning in the moment with students.

My goal in this literature review is to argue that CME needs to do more in this pursuit of justice "by directly confronting the multiplicative effects of injustice and oppression" (Bullock, 2018). For instance, what might CME scholars learn when they engage with ethnomathematics or Indigenous ways of knowing to further advance the goal of critical consciousness raising? How might taking a decolonizing lens help us shift from discussing issues of justice from the present to even challenging the roots of what counts as mathematics? In the next section, I give an overview of ethnomathematics and Indigenous ways of knowing, neither of which has often not been in connected conversation with CME but was evident in the findings of this work.

Ethnomathematics and Indigenous Ways of Knowing

Though referenced often as a backdrop, CME scholars do not connect ethnomathematics and Indigenous ways of knowing scholarship as another way mathematics can be leveraged for critical consciousness-raising in students. Dubbs (2020) reported that this separation can be found in his research mapping the citation analysis in three notable mathematics education journals. Francois and Stathopoulou (2012) assert that there are connections between CME and ethnomathematics in that both approaches discuss the socio-cultural and sociopolitical facets of mathematics. I submit that when members of communities engage in ethnomathematics investigation, there is also a development of critical consciousness that is valuable. Although I see ethnomathematics and Indigenous ways of knowing as similar, I recognize that ethnomathematics has been taken up in problematic ways that centered a Eurocentric lens (Dowling, 1998; Wolfmeyer, 2017). Before getting far along into critiques of ethnomathematics, I will provide a brief review of the ethnomathematics/Indigenous ways of knowing literature because the valuing of multiple ways of knowing is a core component of this study. Furthermore, the ideas related to both ideas are apparent in the findings I will share.

D'Ambrosio (1985) laid the foundation for the development of ethnomathematics, which approaches the teaching of mathematics from a historical and anthropological perspective. He aimed to develop this approach in mathematics, as others had done in other disciplines. He noted that although anthropologists have recorded the development and use of mathematical practices, mathematicians had taken up this field of research in very limited ways. He was struck by the contrasts between the way mathematics is developed and practiced—as evidenced by much anthropological research—and the way mathematics is taught in schools.

Ethnomathematics is defined as a field that recognizes how different forms of mathematics arise from different modes of thought (D'Ambrosio, 1985). The field of ethnomathematics bridges research completed by anthropologists and historians of culture and mathematicians. Additionally, ethnomathematics is the mathematics practiced by identifiable cultural groups. The use of the phrase "cultural groups" also extends beyond ethnic culture to "labor groups, children of a certain age bracket, professional classes, and so on" (D'Ambrosio, 1985, p. 45). Other scholars expand on D'Ambrosio's concept of ethnomathematics to include the examination of the social, historical, and political factors that have shaped academic mathematics into the form we know and use today and to form a bridge between community mathematical practices and school mathematics (Gerdes, 1985, 1988, 1997; Pais, 2011; Vithal & Skovsmose, 1997; Wagner & Borden, 2015). Vithal and Skovsmose (1997) considered ethnomathematics to be a "reaction to the cultural imperialism which is built into modernization theory," with the main purpose of developing mathematics curriculum from "culturally embedded mathematical competencies" (p. 132).

In many regards, ethnomathematics is similar to research focused on Indigenous ways of knowing in mathematics (e.g. Cajete, 2012; Lipka et al., 2012; Meaney, Trinick, & Fairhall,

2013) but with notable exceptions. Indigenous ways of knowing research is often conducted by members of the same or adjacent communities, whereas ethnomathematics research has often been conducted by Europeans whose goal is to "uncover" mathematics within non-western societies. Researchers have presented critiques of ethnomathematics in theory and in practice (Dowling, 1998; Pais, 2011; Vithal & Skovsmose, 1997; Wolfmeyer, 2017). Pais (2002) presented epistemological criticisms (that mathematics is a neutral space) and educational criticisms (that formal mathematics should be privileged to improve students' chances of upward mobility) about ethnomathematics. Pais' argument centers on his belief that ethnomathematics should question the role of school in society, which had not yet been taken up. Additionally, considerations about politics and power relations for school mathematics are entertained (Vithal & Skovsmose, 1997). Vithal and Skovsmose contend that ethnomathematics attempts to translate local/ethnic mathematics into classrooms (formal) settings which they argue, loses its purpose. Wolfmeyer (2017) holds that it could also be problematic and objectifying when trying to mathematize practices of the Other. D'Ambrosio (1997) also offered criticisms to the way ethnomathematics has been taken up. He stated, "much of the research in Ethnomathematics today has been directed at uncovering small achievements and practices in non-Western cultures that resemble Western mathematics" (D'Ambrosio, 1997, p. 15).

Wagner and Borden (2015) provide a specific example of some of the challenges and issues involved in applying ethnomathematics research to classroom curriculum and pedagogy for a particular community. While engaging in ethnomathematics research with the Mi'kmaw community, they addressed the critique of ethnomathematics as being a Eurocentric practice that involves outsiders finding value in community practices by revealing the mathematics within. Although they acknowledged the validity of this point, they also pointed out that practices

identified by Mi'kmaw elders already hold intrinsic value to the community, whether or not those practices are translated into European concepts of mathematics. Additionally, they argue, "there is no Mi'kmaw word for mathematics, so it is unreasonable to expect Mi'kmaw tradition to identify practices as mathematical" (Wagner & Borden, 2015, p. 117). Nevertheless, Mi'kmaw elders were able to identify examples of mathematics in their common practices, without assistance from the mathematics experts. When speaking about these practices, they continually emphasized necessity and common sense. This led the researchers to conclude that mathematics curriculum must be grounded in students' experiences, and that "students' production of meaning should rather relate to their tasks as humans, addressing community needs" (Wagner & Borden, 2015, p. 123). Wagner and Borden discussed learning mathematics through the process of addressing community issues and allowing communities the agency to choose what types of mathematics they might need to adopt or adapt, blurring the lines between mathematics for social justice, critical theory, and ethnomathematics.

This study expands the body of literature in ethnomathematics by showing that the recognition of mathematics by members of communities is a powerful way of allowing these community members to feel a sense of ownership of their mathematics. Moreover, I contend that in the context of decolonizing African education, it is imperative not simply to start from the mathematics as it is known now, but to return to the past (i.e., Sankofa) by recognizing the deep knowledges that already existed in communities before colonization. This leads to my discussion of decolonial theory that follows.

Decolonial Theory

Patel (2016) challenged, "many theories can be used to explain experiences and data, but they do not do so equally" (p. 60). In this vein, I draw heavily on the work of Zimbabwean

decolonial theorist Sabelo Ndlovu-Gatsheni who builds his imagining of decolonial theory from elders like Walter Mignolo, Sylvia Wynter, Franz Fanon, amongst others. For Ndlovu-Gatsheni (2015), decolonial theory disrupts the impact of coloniality within the spheres of power, knowledge, and being. Coloniality of power calls into question "the world of those in charge of global power structures and beneficiaries of modernity" (p. 489). Essentially, colonialism produced a "zone of being" and a "zone of none-being" wherein the former constituted global powers and the latter were victims of slavery and colonization (Ndlovu-Gatsheni, 2015). Coloniality of knowledge pushed aside Indigenous ways of knowing and purported western knowledge as a singular base. Lastly, coloniality of being speaks to the questioning of who gets to be regarded as human. Coloniality of being "assists in investigating how African humanity was questioned" (Ndlovu-Gatsheni, 2015, p. 490).

Decolonial theory thus takes on a liberatory and activist lens as it seeks to center the colonized Other. It allows for a,

> re-telling of history of humanity and knowledge from the vantage point of those epistemic sites that received the 'darker side' of modernity, including re-telling the story of knowledge generation as involving borrowings, appropriations, epistemicides, and denials of humanity of other people as part of the story of science. It is also a call for democratization of knowledge, de-hegemonization of knowledge, de-westernization of knowledge, and de-Europeanization of knowledge. (Ndlovu-Gatsheni, 2015, p. 492)

Ndlovu-Gatsheni (2018) further asserts that decolonial theory widens our view on social justice to include cognitive justice as a way to shift towards epistemic freedom. Cognitive justice acknowledges the epistemicide that was wrought upon the colonized Other by the intentional attempt of killing and disvaluing Indigenous knowledges. Thus, epistemic freedom "is

fundamentally about the right to think, theorise, interpret the world, develop own methodologies and write from where one is located and unencumbered by Eurocentrism" (Ndlovu-Gatsheni, 2018, p. 17). Engaging in this process of epistemic freedom engenders what Ndlovu-Gatsheni termed *critical decolonial consciousness.* Building on Abdi (2002), epistemic freedom expands knowledges to include those forms of knowledges that are not solely philosophical and scientific forms. These forms of knowing also include Indigenous ways of knowing that emphasize "relational knowing, intuition-reasoning and empathy" (Greene, 2019, p. 95) that have been labelled "myths, superstitions, and non-science" (Boutte, Johnson, & Muki, 2019, p. 15).

Decolonial theory supports this dissertation research as it allowed me to question the classical (school mathematics) knowledge that is often centered in CME work and expand on what constitutes community and critical knowledges (Gutstein, 2007). Moreover, I shifted the "center" of this research away from a United States or European centered framework to one rooted in African thought. In addition, decolonial theory allowed me and co-researchers to consider possibilities of what mathematics for social justice could entail in our own contexts.

Chapter 3: Planting the Baobab Tree

"To be African is to confront in one breath all the beauty and injustice of this world. To be African is to feel inspired, called and impelled by shared humanity to do good, hard work – hand in hand with others." (Eltayeb, 2018)

Using decolonizing methodologies aligned with the purpose of this dissertation, research questions, and frameworks. Decolonizing methodologies build from decolonial theories as an approach to engage in research that centers the worldviews of the colonized Other and that is relational (Chilisa, 2012; Patel, 2016; Smith, 1999; Wilson, 2008). In other words, decolonizing methodologies shifts from a western way of conducting research by foregrounding and elevating multiple knowledges. Chilisa (2012) states, "decolonization is thus a process of conducting research in such a way that the worldviews of those who have suffered a long history of oppression and marginalization are given space to communicate from their frames of reference" (p. 14). A decolonizing approach to research also allows research participants with healing, transformation, and self-determination (Smith, 1999). In this research, I ensured that I offered space for myself and the youth co-researchers to share from our own experiences and ways of knowing embedded in our communities, which I share later in this chapter and in Chapter 4.

I purposefully intended for this dissertation to be a decolonizing project guided by three African frameworks: Ubuntu, Sankofa, and Fela-Anikulapo Music (FAM) methodology (FAM). I explained these frameworks in Chapter 1 but will provide a quick summary here. Ubuntu (Tutu, 1999) is a Southern African philosophy emphasizing that *I am because we are*. Sankofa (Dei, 2012) is from the Twi people in Ghana and asserts, that we must look into our past before reflecting on the future. Lastly, I coined FAM from Fela's music which has three main facets including co-learning, disruption, and joy. These three frameworks speak to ways of being, ways of knowing, and ways of doing, respectively countering the coloniality of power, knowledge, and

being (Ndlovu-Gatsheni, 2018). In the sections that follow, I address these guiding frameworks. Rather than explicate them separately into theoretical, conceptual, and methodological as is traditional, I view them in relation, as cyclical and interwoven—which reflects a decolonial stance and practice. In this section, I explicate these concepts further and end by connecting them with CME.

Research Design

I acknowledge here that I use headings that are steeped in western ways of conducting research. I have tried to both use and trouble these naming patterns and reflect further on this in the concluding chapter. Recognizing that my goal was to work alongside co-researchers in this study, it was still important for me to have some initial plans going into this study. I begin by sharing background information on co-researchers and then I discuss the methods for collecting and analyzing data for this project.

Co-researchers

I used a snowball method in recruiting co-researchers for my study. I met with a former high school student of mine (from Cote d'Ivoire) who was an upper-class student at a large midwestern university in Spring 2018. I gave her insight into the proposed project and spoke to her about a social issue she often thinks about related to her country as an example. She discussed the issue related to mental illness stigma in her country and we had an extensive conversation about topics like the historical context of mental illness in her country, number of mental illness facilities that exist in her community, the number of people each facility serves, and even conducting a small-scale study to understand this issue both qualitatively and quantitatively. After this process, she saw the value in my project and helped me reach out to rising Sub-Saharan African sophomores at the same university.

My reason for working with sophomores was that the jitters of the first year would have faded and moreover, these students would still be well connected to their African countries. In May 2018, I met with five African youth for a little over an hour to share my hopes for this study. I also created a WhatsApp messaging group that we used to communicate before, during, and after the study. Our FAM group comprised of one youth who identified as male and four who identified as female. Table 1 shows their names (pseudonyms) and their country of origin.

Table 1. Names and demographics of co-researchers

Name (chosen pseudonym)	Country of origin	Gender
Njo	The Gambia	Female
Manyoni	Zimbabwe	Female
Mendrika	Madagascar	Female
Sanyu	Uganda	Female
Soro	Cote d'Ivoire	Male

Each of these African youth are international students in the United States and are attending a large midwestern university. They are all sponsored by the same foundation and all plan to return to their countries because, as Manyoni stated in our initial meeting, they cannot be their full selves in the United States. Though I had initially intended that they each be enrolled in a mathematics course in the semester that we worked together, it did not prove necessary as we focused on our mathematics experiences.

The Stories We Tell: Data Generation

As previously noted, co-researchers and I met in a physical location 10 times and twice virtually via video conferencing due to weather and travel conflicts, for approximately two hours each session during the spring 2019 semester (see Table 2). All sessions were video, and audio recorded. After each session, I wrote detailed notes in my journal and sometimes recorded voice-memos that I transcribed.

Table 2. Data generation schedule

Date	Description	Youth Present
Nov 21, 2018	Initial revisiting of purpose of study in my house	All
Dec 18, 2018	Zoom meeting to create draft schedule	Manyoni, Mendrika, Njo, Soro
Jan 9, 2019	Monopoly game	Manyoni, Mendrika, Njo, Soro
Jan 16, 2019	Identity narrative	All
Jan 23, 2019	Cancelled due to a family tragedy with one youth	All
Jan 31, 2019	Met via zoom due to weather. Discussed education journey	All
Feb 6, 2019	Brainstormed social issues	Manyoni, Mendrika, Sanyu, Soro
Feb 13, 2019	Discussed mathematics Indigenous knowledges	Mendrika, Njo, Sanyu, Soro
Feb 27, 2019	Narrowed down social issues	All
Mar 13, 2019	Discussed approach to understand and disrupt social issues	All
Mar 20, 2019	Developed survey	Manyoni, Njo, Sanyu, Soro
Mar 27, 2019	Discussed mathematics implications of social issue	Manyoni, Mendrika, Njo, Soro
Apr 3, 2019	Met via zoom and reviewed initial survey result	All
Apr 10, 2019	Finished survey analysis and made recommendations	All
Apr 17, 2019	Reflection of the whole process	All

These memos typically began with general housekeeping such as if someone was late or absent. Then, I wrote about the key insights from the session and how I saw elements of the frameworks in the session. I wrote about my role as a co-researcher as well as conflicts I felt in the research space. For instance, when I noticed that I was being positioned as a "teacher" and not an equal partner in the space, I wrote about how I felt along with the tension I was grappling with. For example, in my memo from the February 11 session, I wrote "Why these social issues?

Where do they come from and what is our connection to them?", "I also wonder what it is that we want to disrupt? When is it okay for me to disrupt?" Along with questions, I wrote out some of my responses to these questions and I also shared my memos with the group. I did this frequently because I was committed to disrupting the power hierarchies in the space. I also wrote reflections from informal meetings such as our introductory meeting and the movie session we held in the middle of the semester. In addition, we utilized a WhatsApp group called "FAM research group" for communicating schedules, ideas, "ah-ha" moments that emerged when we were apart, and to stay in touch even long after the research ended. I captured all messages sent in our WhatsApp group, which continues to be active.

Youth and I co-generated data as we investigated social issues while simultaneously theorizing the goal of CME in an African context. We used a storytelling approach during the sessions instead of relying on prescribed interview questions. For example, in our first full session, I asked each of us to share "what Africa means to us," leading to rich stories that overlapped. I share more details of this in Chapter 4. Datta (2018) remarks that "stories reflect the genuine and authentic experience of an individual, a team, or a community" (p. 36). Moreover "our stories are a way to understand ourselves and our world … and our stories are a way to prevent our spirits from being ripped apart" (Smith, 2019, p. 109). Utilizing storytelling was also a way to build collaboration and reflexivity in the research.

I am intentional in calling this section "data generation" as opposed to "data collection" because I along with co-researchers collectively generated the data that made this study possible. For instance, I naively believed we could complete our work together in two months, but during one of our pre-meetings Mendrika felt that we would need more time and the others echoed her

sentiment. I made the necessary changes to the IRB as we planned for a semester-long study. In doing this, I was transparent in seeking consent at all times and not only at the start of the study.

Data generation occurred loosely around three phases. Borrowing from Laenui's (2000) work on decolonizing methodologies, I labeled the three phases as follows: phase I (rediscovery and recovery), phase II (dreaming), and phase III (commitment and action). The unfolding of these phases occurred collectively but I found it helpful to have a loose plan to guide the work. Nevertheless, I engaged in what Koro-Ljungberg (2012) termed methodological movement in critical qualitative research wherein I ensured that my methodologies allowed for variation in knowledges and open-endedness of processes as necessary. The data generated for analysis was primarily the storytelling conversations and memos I wrote throughout semester-long exploration. Below I discuss the flow of these conversations across the three phases.

Phase I (Rediscovery and Recovery)

Drawing on Sankofa, that is, to look back and then look forward, the first phase of data generation consisted of playing the Lagos version of the popular game Monopoly, discussing our prior mathematics education and pre-colonial education.

Monopoly game. Co-researchers asked that we have a game night the next time we met and coincidentally, I received the Lagos version of Monopoly (Magie & Darrow, 2012) in the summer of 2018. After playing it with a family member, I realized that this particular version of Monopoly would be a perfect exercise to allow us to practice Sankofa. Before the start of the game, I asked the co-researchers to be attentive to aspects of the game that stood out to them. For instance, why were some properties worth much less than others? Why did mortgage prices change across properties? Why was jail a feature of the Lagos version much like the original American version? Did any of the *chance* or *community* cards stand out? Playing Monopoly

served as a community-building exercise which brought a lightness and joy to center the space extending notions of FAM. The conversation that ensued began the journey of rewriting African narratives and disrupting the overreliance on western ways of being and knowing particularly in [mathematics] education.

Identity narratives. Examining aspects of self is important particularly as it relates to decolonizing research (Dei & Simmons, 2012). An identity narrative veers away from the traditional questioning regarding demographics. Instead, identity narratives open space for Indigenous peoples to share powerful stories about themselves or their histories (Chilisa, Major, & Khudu-Peterson, 2017). Chilisa, Major, and Khudu-Petersen assert that identity narratives are a decolonizing act as it allows individuals to describe themselves as they wish instead of the researcher creating narratives for them. In addition, identity narratives allowed me and co-researchers to "develop awareness of oneself and of belongingness and of their responsibilities to one another and to the environment" (Chilisa et al., 2017, p. 333). Recall that Dei (2012) also posited that African ways of knowing require that we center past histories, identities, and experiences as we reflect on our roles as change agents in our communities.

During a professional development session for one of my research assistantships, Maisie Gholson asked the collective group to use recyclable materials to describe our mathematics journey. I wrote the following in my memo, "yesterday, Maisie had us use recycled materials to showcase our math journeys. It got me thinking about what we can do in FAM. Shall we use images, music, books, people?" (January 13, 2019). In a session following the Monopoly activity, we began our identity narratives by picking a picture that described "what African means to us." In this research, I argue that the sharing of identity narratives does not take place once-off; instead, because of the centrality of community, we all continually shared our identity

narratives throughout the research. It was a beautiful session. The group enjoyed the collective co-sharing so much that they decided that it was best to continue in this format as we discussed our mathematics experiences and pre-colonial African education. Our conversation veered into other topics (such as embedded mathematics practices within our communities), which I discuss in the findings chapter. The data generated in this phase included the pictures shared along with the storytelling conversation that ensued during four sessions.

Phase II (Dreaming)

In phase two, we spent time identifying various social issues to investigate. Because co-exploring is the focus of this study, we investigated these social issues together.

Identifying social issues. Before beginning to brainstorm social issues, we read, watched, and listened to stories about Africans who have identified a social issue and considered what they did to disrupt these issues. This builds on scholars (Raygoza, 2016; Terry, 2009) who have done a similar process in participatory research with youth. In addition, engaging in this process allowed us to heed Nyerere's (1967) call to diversify the knowledge sources we draw upon. Once more, I wanted this to be a collaborative process, so I first asked each of us to identify an African who tried to disrupt a social issue in their community and to share the person's journey with the group. For example, initially, I shared about William Kamkwamba's TED talk on his windmill creation in Malawi and the late Kenyan environmentalist, Wangari Maathai. Coincidentally, a film about William Kamkwamba premiered on Netflix during our work together. I watched it with Soro and Sanyu over spring break. In Table 3, I specify the process we engaged in at this stage of the study.

Table 3. Process of identifying social issues

Stages	Description	Reflection questions
Reviewing examples	Each co-researcher gathered an example for the group to engage with	How did they come about the issue? What sources of knowledge did they draw on? What was their process in attempting to disrupt? What were their action steps?
Brainstorm	Each person identifies 2-3 social issues	How have you come about this issue? What do you want to disrupt? What prior knowledge/experience are you bringing into this?
Process	Discuss how we want to engage in investigating these social issues	We will decide together how many we can tackle in the time we spend together and if we want to engage each issue individually or in a group

Exploring social issues. I encouraged co-researchers to consider the different knowledges they brought into the space initially and as the research progressed. For instance, I clarified that they could draw on their own experiences, including but not limited to home knowledge or school knowledge. I provide a more detailed exploration of this process in Chapter 4. This differed from other iterations of CME in which the mathematics topic of focus was initiated by the instructor. Given that the youth are also university students, I was mindful of the limited time they had in their schedules. In Table 4, I describe an example of a social issue and the possible process of exploration. In the findings I elucidate more on the messiness of this process and how it unfolded in our study.

Table 4. Travel within Africa by Africans

Stages	Plan/Questions
Recovery & Rediscovery	What are we disrupting? Why does it matter? What is the history of movement amongst Africans on the continent? What has been our experiences traveling on the continent? What impact did colonization have on movement? What is the impact of regional entities (ECOWAS, SADC, etc) on travel within the continent? What is the visa process required to visit our individual countries?
Dreaming	Design survey to send to Africans that includes questions to understand the impact lack of visa-travel is to them. Conduct qualitative interview of a sub-set of Africans while ensuring a diversity in age, nationality, and current residence.
Commitment & Action	Analyze the data collected from the survey and interviews to consider a proposal to address issue. Share findings at the African Graduate Student Association annual spring conference.

Phase III (Commitment & Action)

In the final phase of the project, we drew on Sankofa once more by reflecting on the overall process as a group. We revisited the activities from Phases I and II and considered our vision of CME in African contexts. Baldwin (1988) stated that "as one begins to become conscious one begins to examine the society in which he is being educated." Thus, when we revisited our identity narratives, we explored how we had grown in our understanding of self, community, and the social issue investigated. Since "transformation of social realities must start with re-conceptualizing education, e.g., asking new questions about the what's, how's, and why's of education" (Dei, 2012, p. 104), this reflection allowed us to ask new questions about what mathematics offers to consider how it might be impactful in our context.

Following this reflection, we discussed action steps we hoped to take in sharing our work broadly particularly with our communities.

Making Sense of our Stories: Data Analysis

In the course of generating data with co-researchers, I was unsure about what data analysis would mean in my work. I did not want to use the version I was inculcated into in graduate school when someone "codes" ideas into small chunks and minute details and then builds them all back together into a bigger picture; this process seemed counterintuitive (Tuck & Yang, 2014; Wilson, 2008). The word *code* itself implied the disintegrating of the words we spoke in an a-personal, and a-communal way that was in opposition to Sankofa, Ubuntu, and FAM. I recall that in my dissertation proposal, I safely took the road often traveled, which incidentally is an antithesis to the constant disruption of the norm during the sessions. I wrote about coding and thematizing as is done and expected in qualitative research. I am grateful to my committee for seeing right through me and calling me out. They challenged me to dig into literature and analyze in a manner that supports the African epistemologies and methodologies I was drawing on. I am grateful that they did.

I read and re-read many pieces and was introduced to Deleuze and Guattari's (1987) rhizomatic analysis. Rhizomes, unlike trees, have no roots but instead have multiple entry points. Kamberelis (2004) defines rhizomes as "an accentered, nonhierarchical, memory or central automaton, defined solely by the circulation of states" (p. 21). While I saw possibilities in this non-hierarchical approach particularly around the multiplicities, I had a few concerns. The first concern I encountered was the authors' desire to distance themselves from arborescent ways of thinking (Deleuze & Guattari, 1987). This was problematic in an African context as trees were so deeply embedded in this study. Trees are important life-giving members of our community. Trees

are a place of gathering. A respite from the heat. A place for community. Kenneth Maswabi's (2016) beautiful poem on *The Big African Tree* describes the importance of trees in African communities. Also, Deleuze and Guattari (1987) characterize rhizomes as a-centered with no deep structure, yet myself and co-researchers are deeply rooted and centered on the African continent. I knew immediately that I could not follow this path.

Another concern I was embroiled in was connected to what Tuck and Yang (2014) addressed as refusal in research. Tuck and Yang describe refusal as "a generative stance, not just a "no," but a starting place for other qualitative analyses and interpretations of data" (p. 812). They further explained that refusal should honor commitments and histories while countering settler colonial research practices. Taking a decolonizing stance in my dissertation, I was grateful to discover Wilson's (2008) book on Indigenous research methods. Wilson similarly challenged the western tradition of coding into minute details in order to build back up and make claims. He pondered:

> And if you are saying that an Indigenous methodology includes all these relationships, if you are breaking things down into their smallest pieces, you are destroying all the relationships around it. So an Indigenous style of analysis has to look at all those relations as a whole instead of breaking it down, cause it just won't work. So it has to be more of an intuitive logic, rather than a linear logic because you can't just break everything down into small parts and use linear logic to bring them back together to a whole. You have to use an intuitive logic, where you are looking at the whole thing at once and coming up with your answers through analysis that way. (p. 119)

Relationships are an integral component of the African methodologies that grounded this research (Ubuntu – human because of others; Sankofa – constantly looking back before looking

forward; FAM – co-learning together) therefore, keeping those relations intact was essential for honoring co-researchers. Relational accountability even at the analysis stage meant that I needed to use a method of analysis that further built these relationships (Wilson, 2008). I was reminded of Fela's words "teacher don't teach me nonsense" and as such, wanted to highlight in my analysis how co-researchers were already "speaking" on their own.

I transcribed all the data generated using otter.ai and edited this poorly transcribed data (given that none of us spoke in the normative white accents the program was intended for) from watching the videos. I made notes of cases where voices were high-pitched to emphasize a point or when there was a look of excitement, awe, or sadness on our faces. I wanted to humanize the transcription process as much as possible. As I transcribed, I made comments that connected to other sessions or ideas they generated. After completely transcribing the data, I printed the transcripts out in a binder and read through while thematizing ideas in the margins. For example, I noted re-writing, elders, Sankofa, and western colonization. I wrote memos while making note of key themes, and then read the transcripts alongside the memos. I felt tension as I engaged in this process because it still felt like I was enacting data analysis in the western ways of doing I was steeped in. Using Wilson's (2008) notion of intuitive logic, I returned to the memos I wrote after each session and developed themes from my memos starting with the narratives around what Africa means to us that we developed at the first full session. For example, I noticed a prevalence of ideas around the influence of elders, elderly women in particular, and the impact of western colonization. Within the sub-sections in my findings chapter, I delve into further analysis that was limited to the particular stories presented.

Recognizing that I was approaching my data intuitively as Wilson (2008) stated, I was able to build initial themes reflecting on the sessions as a whole. For instance, I had noticed

multiple instances of re-writing [African narratives] occurring during our sessions. That is, I was able to identify multiple times where we discussed ideas that went against negative narratives often associated with Sub-Saharan Africa. The work of re-reading transcripts was not undertaken to unfold a notion of a single story; rather, re-reading my transcripts multiple times while returning to the videos allowed me to have a "living relationship with it [my data], influencing and being influenced by it, responding to and being responsible for it" (Dillard, 2006, p. 20). Analyzing the data this way was initially helpful in trying to get the broader picture of the data, yet, I was not convinced this was the best way to tell this story because I wanted to ensure that the thread and connectedness across this research would remain even in the writing of the findings. I took time to pause (Patel, 2015) because I needed language around what I was feeling.

I stumbled upon LaVelle's (2007) dissertation with an Indigenous community in Canada. There, LaVelle also offered the importance of telling a collective story. I recall during the first full session when we all told our stories around what Africa means to us. When Soro mentioned the Baobab tree, nearly everyone had a comment to add about it, particularly its importance to community, elders, and storytelling. Thus, considering how to make my analysis and findings represented in a way that embodied Ubuntu remained salient. For example, if I discussed Njo's feelings of joy in realizing the embedded mathematics in her community without connecting it to the comment Sanyu made "wherever you see a right-angle, it means a white man has been there," the reader would not have the same contextualized meaning.

The outlining of themes was an important exercise in guiding my discussion around CME with African youth; however, I will tell the stories by imagining co-researchers and I as part of a collective storytelling (or composite narratives) under a Baobab tree – which I call the fruits of the Baobab tree. No fruit is identical, but each fruit tells a story that connects to the tree. As with

all fruits they generate seeds that reproduce new fruits. Writing the findings as stories allows readers to find new seeds that grow and render newer meanings. African storytelling, is in itself a communal experience (Tuwe, 2016). While African storytelling is traditionally oral, I still believe there is value in using this tradition even in this written dissertation. African storytelling while entertaining, often seeks to inform and to teach a moral lesson. This moral lesson would be the multiple themes enshrined in each of the stories I will present. I honored all of the voices that were a part of the data generation as opposed to selecting data that only answered my research questions. Moreover, I avoided presenting the findings around the themes that emerged to avoid centering my own analysis but rather focus on how co-researchers and I "engaged with the work" (Dunn, Neville, & Vellanki, 2018). Having co-learning as a generative stance meant that I needed to discuss the new knowledge generated and allow new understandings beyond what I initially set out to accomplish in this research.

Though it would have been ideal to not only analyze the data but to create these stories alongside co-researchers, I understood that they were unable to commit the time needed as they had busy college schedules. I did, however, meet with them and also provided them with the entire findings chapter to ensure that I accurately reflected what they said and that any information they did not want to be placed in this public document would not be included.

Chapter 4: The Fruits of the Baobab Tree

"*All of these stories make me who I am. But to insist on only these negative stories is to flatten my experience and to overlook the many other stories that formed me*." – Adichie (2009)

I begin this chapter with the words of Nigerian author Chimamanda Ngozi Adichie admonishing her audience to consider multiple stories and not one, often negative, stereotype. I indicated earlier that fruits generate seeds that reproduce new fruits thus as you read this findings chapter, I invite you to find new seeds that grow and render newer meanings. This findings chapter consists of six sections to honor the six collective voices that brought voice and meaning to this study. I do not organize my findings chapter by directly answering the research questions. Instead, I organize my findings by highlighting how decolonial theory, decolonizing methodologies, and the African frameworks (Ubuntu, Sankofa, and FAM) enabled deep insight that not only answered these questions, but that also created possibilities for CME for Sub-Saharan African youth. In the last chapter (chapter 5), I will return to the three research questions more directly linking the findings back to the literature.

Overview of Findings Chapter

Below I list the six sections that make up this findings chapter with a brief description of each:

"Africa's Single Story"

The first three sections begin with renderings of what Willis (2019) called "composite narratives." Composite narratives are a way to combine individual stories into one to show their interconnectedness. I chose to display some of the findings in this way as it also calls to the way Ubuntu can be infused in the writing of this research. Drawing on Willis' methodology, I do the following:

1. I clearly state whose voices are included in the composite narratives

2. Like Willis, "in the narrative itself, I avoid imposing any judgement on the interviewees' experiences and opinions, and do not assume motivations or feelings" (p. 475). Any comments of this nature in the narrative are taken directly from the interviewees.

In the first section of the findings chapter, I use composite narratives to show the groups' collective understanding of what the African continent means to us. This activity became an important connection throughout the subsequent FAM sessions. This exercise also showed a disruption to the typical narrative around Africa and her people.

"Education is the Key to Success": Complicating Meanings of Education and Success

Here, youth co-researchers and I explore previous mathematics learning particularly at the secondary level. I also use composite narratives in expanding on the similar experiences across the group.

"I Never Liked Maths in School but I Never Knew that I Already Knew Maths!": Investigating Indigenous African Knowledges in Mathematics

After Sanyu made the comment "wherever you see a right-angle, it means a white man has been there," I engaged the group in considering mathematical practices embedded in African communities. Essentially, I drew on decolonial theory to challenge the coloniality of knowledge as being centered in the west.

"As Africans, We Have Our Own Ways That Our Ancestors Healed People": The Beginning of Our Participatory Research Project

In this section, I share the group's entry into the particular social issue we chose to deeply engage with and disrupt the notion that manufactured medicine is more effective than traditional medicines. I further highlight how prior experiences and beliefs impacted the types of social issues that arose during the initial brainstorming session.

"Data Is Like the Most Effective Way": Exploring the Role of Mathematics in Social Issue Research

After collecting and analyzing data for the specific social issue we studied, I explore the role mathematics played in this process. I further expound on the other knowledge sources that came to bear in this process.

"I Feel Like Looking Back Propelled Us Forward"

This last section focused on a reflection on the frameworks that guided this project. I draw on analysis of the group's final collective reflection session along with continued conversation we engaged in after the project was complete.

Africa's Single Story

Recognizing that methodological fluidity is important in critical qualitative research, I was in a workshop where I learned about a different way of sharing my mathematical journey using recyclable materials. Since I did not have a set of recyclable materials available, I asked co-researchers to look for an image that represents what Africa means to us. I asked us all to upload our image on our google document. After we all placed our pictures in the document, we went around in a circle to explain the picture to the group. In some instances, we added stories to other pictures. I have rendered all six of our stories into one composite narrative, as you will see next.

I want to tell a story about Africa, my Africa. Africa is our motherland. Like a mother carrying a child on her back draped in the majestic Ankara fabric, she is our pillar.

Figure 3. Njo's picture

She is constantly looking out for you no matter where you are. Seven days after your birth, she carries you on her back, creating a bond that can never be broken. Her day begins at the crack of dawn as she makes fire, cooks, goes to the farm, clothes the family, yet you remain her focus. Africa our motherland. A mother who is at the frontlines in our education, in agriculture tending to the farms under the immense heat of the sun, in our healthcare detecting our slightest abnormalities. Mothers, seemingly omnipresent. There she is tending to patients, cleaning our hospitals, caring for us. Africa our motherland. She is vulnerable to violence but that does not define her. She is love personified. She is always there. She is everything.

You might leave for years at a time but when you come back, she will accept you the way you are. Though she might have grown older, with wrinkles that tell of all she has given and not received.

Figure 4. Manyoni's picture

Wrinkles that tell how much she has given and yet gone unnoticed. Like an elderly woman, her knowledge is infinite. Many have said Africa is nothing while they take our minerals. They create a dilemma within us. You see, the very air, the very essence, just being in the space that is Africa is gold. They've blinded us to know our truth. They pick at our gold as leaves falling to the ground.

Figure 5. Sanyu's picture

They keep harnessing it in all ways. Like a bird, we hover. We see them interfering in our land. We cannot see our own potential. There is brain drain. We are all trying to run away from the very gold that we are. They keep picking at us. How do we free ourselves without leaving her behind? You want to free yourself from bondage but if the perpetrator is within your house, you don't want to leave your house because it's your house but at the same time, you want to leave. Africa our motherland. We are trying to find our identity, but people are bringing our identity to us. They are defining our identity on our own grounds. They are picking at it little by little. Like a mother's wrinkles though, she has layers. Africa is just tjo[12]! Her tired eyes look at us as if she is asking, "if only you knew how much it took from me." Their hands tell the story of how much they have put in and produced.

Figure 6. Molade's picture

Africa our motherland. Stories of your greatness take me to a different level. You make something out of nothing. You create unimaginable flavor that transcends region. That

[12] "Tjo" is a slang word popular in Southern Africa used when individuals are so amazed by a person, thing, event, etc.

transcends language. Like the spicy taste of Suya, you bring communities together. Like a mother, you gather your children under the great Baobab tree.

Figure 7. Soro's picture

Community. The great Baobab tree sits in the middle of the town reminding us of the hundreds of years of knowledge she holds. Under your shade, we gather for wisdom. We debate. Everyone has a story under the Baobab tree. Community. Africa our motherland. Your creativity is embodied in the Baobab tree. No part of you is wasted. Your bark is used to create ropes. Your stem is used to produce timber. Your fruit. Oh, your fruit. Your succulent tasting fruit. Every part of you enriches our community. Like a woman, you are the center of our community. Elders gather at your trunk to tell ancient stories under the moonlight. Wisdom is shared. Baobab tree is energy. Like an elderly woman, you are resilient. Your long branches remind us that we are all connected and tethered to you. Africa our motherland. We are rooted to you.

After a stormy rain, a stormy rain of colonization, we see the rainbow. The purple, blue, orange, green colors of a beautiful rainbow.

Figure 8. Mendrika's picture

Africa our motherland. Though cloudiness of the world might attempt to hide your beauty, you remain, nonetheless. Together, the colors of the rainbow represent her people. Together, we can achieve beautiful things. When the rain is gone, we will remain. All of us. Resilient like an African woman. Africa our motherland.

Unpacking Africa Narratives

I mentioned in the introduction of this section that the idea for the picture to elicit narratives came to me only a few days before our second session. It did not come from reading research but from allowing myself to engage in methodological fluidity (Chilisa, 2011; Koro-Ljungberg, 2012). Prior to this activity, I sent a message to the group on WhatsApp and asked everyone to bring their laptops to the session. Njo was the first to share on the relationship between Africa and a woman with a baby on her back. When she was done, there was a hush in the room, and I vividly recall my heart expanding. In decolonial and community engaged scholarship, researchers often do not write about the fears that engulf them when they are unsure how the work will pan out. I entered our FAM session on this day completely unsure how it

would all unfold until Njo began sharing her words. We all had about ten minutes to find a picture and discuss our narrative without prior preparation. In Njo's story, I noticed how she began disrupting the typical narrative of an African woman. She spoke with so much joy and light. It was as if she could not find enough words to tell of the power, strength, and importance of an African mother/woman. She recognized that because African mothers are often at the forefront of African homes, they are vulnerable to harm, but she refused to create this singular story about an African woman.

This rewriting of the typical and often negative stories related to Africa resonated in all the stories (Watson & Knight-Manuel, 2017). Sanyu described Africa as gold. I spoke of our creativity. Manyoni detailed the role of elders in African communities. Soro used the Baobab tree to illuminate the importance of community in African society. Mendrika ended with a discussion on pan-Africanism. Note that the order of how we were going to discuss our narratives was not chosen ahead of time yet, Mendrika ending with a discussion of pan-Africanism was a coincidental, yet perfect way to end. In her narrative, she essentially discussed the power of harnessing Ubuntu to allow for collective engagement in seeking solutions to issues. I originally intended to share the stories individually until I realized how interconnected these stories were. In these narratives, I highlight important themes as a composite (or collective) story to show the relationship and interconnectedness between us. Though Adichie (2009) cautions on the danger of a single story because of the negative stereotypes often embroiled within them, my use of composite stories is comprised of multiple stories that in this case show the collective experiences amongst the youth and me. Some important themes arose in these narratives that thread throughout the research space: the role of women in African society, elder knowledge,

impact of western colonization in Africa, centering of community in African society, African ingenuity and creativity, and the collective building of Africans.

The pictures and vivid descriptions that went alongside these images created a shared sense of joy and purpose in our space. For example, as Manyoni spoke about the layered strength and knowledge that represent the wrinkles on the elderly women's faces, she proclaimed, "Africa is just tjo!" "Tjo" is a slang word used in Southern Africa to express delight and amazement when you can no longer find words to express that purpose. At the end of this exercise, I asked the group what they thought about us all speaking pretty positively about our continent even though we recognize that all is not roses at home. Sanyu said,

> Africa has had a single story for so long and like I can't be part of the single story … and the world had focused so much on the negative. That's all they depict that if we are given a chance to show Africa in anyway, you want to try and use the positive.

This recognition of the single story of Africa – either intended or unintended – undergirded the research space.

Elder and Community Knowledge

At the end of this session, I remember thinking: This does not feel like research. What does this have to do with mathematics? What happens next week? Throughout the study, these questions remained and sometimes made me feel like I was floundering. For now, I will begin to answer the second question: what does this have to do with mathematics? The themes that arose in our collective stories give a picture of our envisioning of African society. I wondered: How do we insert elder knowledge in mathematics curriculum? How do we center and elevate girls' voices in mathematics classrooms? How do we "write and rewrite" African stories to show our creativity? How do we involve the broader community in the learning of mathematics?

This past summer (summer of 2019), I co-led a study abroad group to South Africa. I left about two weeks after the completion of data generation. Therefore, the co-construction of knowledge we shared was raw in my consciousness throughout the journey. I will share connections throughout this chapter beginning with this one. We visited a rural junior school (children's age ranges from 8 – 13) in the Eastern Cape province. There, we were invited to observe a mathematics lesson. I noticed that the students only worked individually, the girls did not participate, and students were not allowed to discuss ideas together. In the debrief, I asked the teacher about this pedagogical move and she said that she preferred students to work individually because they were more productive. I remember thinking how antithetical this learning space must be for students whose lives are otherwise centered around community. At a different school in the Western Cape province, we were told about the involvement of Elderly women (Gogos) in school. The Gogos visit children on a regular basis and share stories in their Indigenous language (IsiXhosa). This involvement of elders, who happen to be women, connects to the stories shared in our collective storying. I left this school wondering how powerful it would be to equally involve the Gogos in mathematics spaces.

I invite you to consider these ideas in a mathematics learning context as you read the next four sub-sections that discuss and unpack the learning we did in community. I returned to Wilson (2008) by using intuitive knowledge that resulted from being immersed in this study. I ensured that I was true to what we said by using our words exactly as they were stated. I added a few words that connected the ideas to keep the rhythm of "Africa, our motherland." As I experienced during the data generation process, I am unsure how the restorying of the next chapters will pan out, but I will trust that our words will guide and direct me.

"Education is the Key to Success": Complicating Meanings of Education and Success

In this section, I will share three different narratives drawn from youth co-researchers. In the first that follows, I draw on data generated at a FAM session that Njo led. Building on Sankofa, Njo facilitated the session on exploring our secondary mathematics schooling which then led to exploring our schooling experiences broadly. The italicized narrative comes primarily from Mendrika, Sanyu, Njo, and Manyoni's experiences of mathematics and broadly STEM spaces as gendered spaces. As I described at the start of this chapter, these narratives are taken to represent a collective singular voice. Furthermore, while some of the word choices or tenses might appear strange, note that I am intentional in keeping the integrity of the narratives as they were spoken in our FAM session.

Narrative 1: Gendered Mathematics Spaces

Telling a story about my own mathematics experience would be incomplete without beginning with my education journey generally. As a young girl, I had to find my own reason to stay in school. I had to be stubborn to hold on to that reason to stay in school because usually you do not have any resources that will motivate you to do well in school. I did not have teachers that would encourage me as a girl – oh, you should keep up what you're doing. I didn't. It hurt because the focus was always on the boys. I remember that even the teacher perceived to be the best was usually assigned to the class with the majority boys.

And this was far worse in mathematics and other STEM classes. Maths class was certainly never one of those reasons for me to stay in school. Maths class, in my view, was a space totally colonized by boys in terms of how to do well in it. I think I found myself in the most social science courses when I was in the lower grades like grades five or six. I was attracted to subject areas that allowed me to talk and express myself. Those subjects also helped me

overcome the social pressure related to girls and how our smartness was perceived. Later on, when I told my mum I wanted to do biology, chemistry, and maths, she was so quick to allow me to do what I want as long as it was science and even began telling her friends. Because it was STEM. In fact, I was failing maths but it did not even matter. I was enrolled in math and that's what mattered.

I had a [male] maths teacher who decided to "prove", using logic, that a woman is equal to a problem. I really wish I was lying. He followed a series of steps and proved this. I told myself that I was gonna try really, really hard to show him that women actually can do something. My maths and physics teachers were men and I just feel like I was never empowered as a young girl in those classes. So it was no surprise to me that I failed both subjects. But I knew I was not dumb. I refused to believe that lie. And you know what, my chemistry teacher was a woman and even though I was not doing well earlier on, I would go to office hours. Something about the way she treated me was empowering and I ended up being the top of the class in chemistry. Unfortunately, my mathematics experience was not like this. I felt like, in maths, teachers were more prone to go with boys, because they felt like it's more guarantee that they're going to understand it.

I tried. I tried to befriend my maths teacher and the boys in my class. I would go along with the boys to see our teacher but they would all look at me like I didn't belong. I mean they would imply that I was not going to be able to do anything with the problems. I was always told that education was the key to success, but they forgot to tell me what kind of education. Because I was doing well in other subjects but those did not count if it wasn't maths. So not all education is the key to success. And it kind of crippled me for the longest time, because every time I failed a class, I was like, Oh my God, I'm unsuccessful! Oh, my God, that's it for me. Like, I have no

place in the world. We forget that there's different types of intellect, especially for us Africans. I, I feel like most Africans are artists. We sing, tell stories, act, you know, people do these things, but all those things are looked down upon.

But education is the key to success.

Particular education.

Maths. Science.

Unpacking narrative 1. After two weeks of meeting, our third FAM session was cancelled because of the death of a family member in our FAM community. This family member also happened to be a prominent African, well-respected around the continent particularly in Southern Africa. Instead of a formal meeting, we gathered to sign a card and gathered some food to give to the FAM member who was hurting. In addition to this, there was a snowstorm the following week that caused us to meet using the Zoom software. I noted in my journal that I was feeling uncertain with Njo was leading this session because, despite my commitment to making the space collaborative, I found it hard to let go. Moreover, we ended our first full session (where we discussed the pictures) with questions related to the direction of the project. I was always honest in sharing with the group that though I saw value in spending some time looking back on our own experiences, I was unsure if there would be a sense of cohesion between engaging Sankofa, and the exploration of the social issues. Nevertheless, I trusted the African frameworks that were guiding this work and believed that the connection would become evident as we went along. I was trying to learn to live in the discomfort and tension this brought, and I asked the youth co-researchers to journey in this with me even as they also experienced discomfort and tension as to the direction of our research.

As I report earlier, Njo led this session and asked that we each speak about our education journeys broadly and mathematics specifically. She also asked that we share proverbs from our communities related to education that stood out to us. Because of the design of this study, there were no other prompts or questions to guide this exploration. As I thought about the role of Ubuntu and FAM in this research, I was struck by the disappearance of these constructs as they described their gendered [mathematics] learning. In the first section of this chapter, Njo and Manyoni gave vivid, beautiful descriptions of their perception of a [Black] African woman while also highlighting the role of this African woman in African society. Njo and Manyoni spoke with joy, admiration, and gratitude of the strength of this African woman in our communities yet the joy they exuded disappeared in the context of mathematics. Even though the prompt Njo gave to the group at the start of this session was broad and focused on education, the discussion quickly led to the gendered nature of schooling in our societies with a particular emphasis in mathematics classrooms. Njo began by sharing the proverb "A banana republic" which she learned in the seventh or eighth grade. She asked her male teacher what it meant, and he said it was a proverb describing a [nation] state led by a woman. Her teacher went on to say that because a banana is soft on the inside making it "odd," a woman leading a nation state is equally odd. The idea of a woman leader was so out of the ordinary for Njo's teacher that this belief seeped into Njo's experience in mathematics spaces.

Early on, Njo expressed that mathematics classrooms were "colonized by boys" and I was struck by her use of "colonization" here. Colonization is often associated with anger and sadness about the intrusion of white people on African land. Thus, Njo's use of this term is not to be taken lightly. She meant to invoke the silencing she felt as a young woman in that space. Njo even noted how she gravitated towards classes that "allowed me to talk and express myself."

Though I did not know this at the time of our discussions, as I have spent time analyzing and interpreting this data, I have wondered how CME could possibly thrive on the African continent if there is not an intentional attempt to dismantle the gendered nature of our spaces (and society broadly) first. Wane (2008) reminds us of the importance of African women in African society as they tend to be the keepers of traditional knowledge and are often at the forefront of the resistance movement. Moreover, Wane asserts that any form of decolonial discourse, which I argue CME embodies, must "problematize the marginalization of certain voices and ideas in the educational system, as well as the delegitimization, in the pedagogic and communicative practices of schools, of the knowledge and experiences of subordinate groups" (p. 194).

Sanyu and Mendrika also expressed similar views about their mathematics classrooms. Mendrika explained that her male mathematics teacher went so far as to "prove, using mathematics," that women were not capable of thriving in the subject area. As the young women discussed their dehumanizing experiences in mathematics, it was evident why engaging in Sankofa was important. Sankofa enabled us to build a community where some members either felt connected in their shared negative mathematics experiences or others could empathize with these experiences. Previously reported research of CME often began with an issue from the local or broader community without discussing how they began their inquiry with having students reflect on their own relationship with mathematics (a notable exception being Raygoza, 2016). When Sanyu spoke of her mathematics experience, it was as though she was experiencing her frustration all over again. She said "…and it kind of crippled me for the longest time, because every time I failed a [mathematics] class, I was like, oh my God, I'm unsuccessful! Oh, my God, that's it for me. Like, I have no place in the world."

I began this sub-section by expressing my fear that employing Sankofa to look back before moving forward would yield no useful results. But building with Sankofa actually created space for Njo, Sanyu, Manyoni, and Mendrika to share the harmful experiences they each had in their mathematics classrooms. Unlike the joy that they felt talking about Africa as a whole, they expressed a range of emotions like frustration, sadness, and anger in discussing their mathematics learning in their respective countries. I began wondering what harm I was doing even in including mathematics in this space, yet I also considered that they each wanted to be in this space possibly to re-write their own mathematics experiences.

For instance, Sanyu pointed out she knew she was capable of succeeding in mathematics and other STEM subjects if she was provided with adequate support that did not make her feel less than her male counterparts simply because of her gender. She shared about the success she experienced in chemistry largely due to her renewed sense of "empowerment" because of her supportive female teacher. This affirms the need to attend to the pedagogy in mathematics spaces before beginning to interrogate social issues together.

In many ways, the young women co-researchers were "mourning their loss of self" in their mathematics spaces. Mourning is an important component of the decolonizing process as this is needed before one can consider dreaming and imagining a new future (Chilisa, 2012; Laenui, 2000). In shifting from mourning towards dreaming, I share the anthem of the African Union, which Njo shared with the group:

> Let us all unite and celebrate together. The victories won for our liberation. Let us dedicate ourselves to rise together. To defend our liberty and unity. O Sons and Daughters of Africa. Flesh of the Sun and Flesh of the Sky. Let us make Africa the Tree of Life. Let us all unite and sing together. To uphold the bonds that frame our destiny. Let us dedicate

ourselves to fight together. For lasting peace and justice on earth. O Sons and Daughters of Africa. Flesh of the Sun and Flesh of the Sky. Let us make Africa the Tree of Life. Let us all unite and toil together. To give the best we have to Africa. The cradle of mankind and fount of culture. Our pride and hope at break of dawn. O Sons and Daughters of Africa. Flesh of the Sun and Flesh of the Sky. Let us make Africa the Tree of Life.

Njo was first drawn to the description of Africans as sons and daughters of the African continent. I posit that her own gendered experiences in school led her to notice this positioning. Unfortunately, mathematics spaces for many speak only to the sons and not to the daughters and other non-binary identifying Africans. Given that the young women co-researchers immediately focused on the role of gender in their mathematics learning experiences, I posit that dismantling the oppression young girls face in this space would be an immediate first step and an act of justice in itself.

Shifting from the gendered narrative in mathematics spaces, the second narrative that follows discusses youth interrogation of western forms of education. All youth voices are present in this narrative.

Narrative 2: Challenging Western Education

I've always wondered about the meaning of education. I mean, I was told education is the key for success. But when I think about it, I do not believe education means that we have to be in a formal school. I've been thinking. I've been thinking about education in pre-colonial times. I've been thinking about what it means to change the idea that education is not sitting in the classroom and listening to your teacher. I am thinking about the forms of education that existed before colonization.

I've been thinking about the colonizers. When they came to Africa, they met people. They did not come to empty villages. They met Africans. Africans who did not have clothes on. Africans who cooked in mud pots. To them, this meant we were uneducated. They discussed us using derogatory words [to the outside world]. But honestly, those were lies. We were not illiterate. We had families we were raising. We had rules and regulations. We had communal laws. We had criminal courts. We had institutions that could actually lead to nationalism to any stage of nationhood.

But when they came…these people,

had so much power.

They spoke in different languages. They dressed differently. They had gunpowder with them. They had many sources of power that Africans could not really relate to. They tried to rob us of our identity. We did not know why they were on our land. And then we knew. They captured us. They renamed us a colony. Our elders did not know how to react.

But that doesn't mean they were not smart.

That doesn't mean they were not wise.

They had a lot of wisdom.

We, as Africans still have a history. We still have a culture. Africans were not recognized for what they had before. Even when we think about how history is taught; it starts with white people arriving at the shores of Africa. If our elders were not there, if they were not living that life and not having those traditions, we wouldn't relate to anything right now. So, I think there was a lot of education. There was a lot of knowledge at home at the time.

It was just a different type of knowledge.

It was totally like pushed aside.

It was connoted as illiteracy.

So I think this is where the problem lies. We have a different knowledge of education. I keep wondering, what defines education for Africans? It's actually the definition that we got from the outside world not that one we used to know as Africans. I feel like this needs to be changed for us to really value our education. The thing I wonder about though is that we don't live in Africa alone nowadays. I think that's where science, research, and data come in. These can give more power to what we in Africa have been valuing so much about Africa.

I recognize the need to want to compete, I get it, I guess, but at the expense of completely abandoning our way of doing things? For us, so much learning took place under the Baobab tree but they are never really appreciated. This type of knowledge is never really considered as having much of an impact on us. We learned in community. And now, we don't even value our own national curriculum. We would rather choose the Cambridge A-level instead of the Nigerian curriculum. I think it is just really problematic.

Unpacking narrative 2. The second narrative was an overlaying of the conversation told by every member of the research space. I was intentional in constructing this narrative in a zig-zag manner to emphasize key ideas that were shared. For instance, I wanted to underscore the connection between "these people, had so much power", "they had a lot of wisdom", and "it was just a different type of knowledge."

The conversation shifted from gender to the impact colonization has had on African education. As is evident in decolonizing work, my analysis revealed a shift from mourning the loss of our pre-colonial education practices to rewriting false depictions of Africans by western influences. Yet, I also noticed a deference to accepting western forms of learning to ensure that Africa is competitive on the global stage. This dichotomy (mourning the loss of pre-colonial

education while still accepting western forms of learning) is reflective of Sanyu's narrative in the "what Africa means to me" section of this chapter. There, she described Africans as birds who hover above their homes trying to decide whether to stay or to leave.

Njo spoke about the way Africans were portrayed when colonizers first arrived on shores. She contested that because our ways of knowing were radically different from what the colonizers had known, we were immediately seen as less than because we were different from their norm. Our clothing was different, our form of cooking was different, and our form of learning was certainly different. We learned in community which did not necessarily mean sitting in a formal traditional classroom. Njo went on to give examples of structures we had in our community to challenge the notion that we were a barbaric, savage, and uncivilized people - words that have been used to describe Africans often.

Despite this attempt to rob Africans of their Indigenous ways of knowing, elders held on to customs and traditions that remain in African societies till this day. My analysis showed that there was a clear rejection and disruption of false narratives. One such narrative the group disrupted was the connotation of African elders as illiterate. They were quick to point to the diverse forms of knowledge that elders have. Like Abdi (2002), the youth co-researchers further rejected the notion that African history began with the arrival of white colonialists on African land.

Yet, there is still the need, and perhaps even a desire, to want to prove our rightful place in the world. Soro mentioned that perhaps, we can use "data and research" to provide credence to what Africans value as knowledges. The sentiment behind this insinuates that science and data are objective forms of knowing whose results would be taken as credible truth. However, there are countless studies to dispute this notion that data and sciences are neutral enterprises (Fasheh,

1997; Gonzalez, 2009; Gregson, 2013; Joseph, Hailu, & Boston 2017; Martin, Gholson, & Leonard, 2010; Nasir, Hand, & Taylor, 2008; Nolan, 2009; Vithal, 2012). Essentially, Soro posits that "proving" the worth of African knowledge systems might be effective in countering the heavy reliance many African societies have in using curriculum created in many cases by colonizers. For example, prominent Nigerian secondary schools pride themselves in using the Cambridge A-Level curriculum over the local Nigerian curriculum. A quick look at the literature list provided by the Cambridge examining board reflects a canon of texts that is widely written by white authors. Thus, even while African societies might value their own pre-colonial education, there is a feeling in wanting to be seen as good enough even by the same people who brought us much harm. As a parallel illustration, Setati (2008) argued that even African nationalist leaders who fought against Apartheid were supporters of English as the medium of language in schooling. In Setati's study, she detailed that the teachers she worked with preferred English as the language of instruction in mathematics because of the political ramification of this choice. In their view, to deny learners access to English would limit their access to social goods and upward mobility in society. Similarly, I contend that Soro is mindful of the ramifications of defaulting to African knowledge sources that do not *hold value* in dominant contexts as this could further marginalize communities.

As I wrote previously, I spent the summer of 2019 in South Africa co-leading a study abroad trip and my dissertation was a mainstay in my thoughts throughout that summer. I reflected on the learning I did alongside the five youth in this study in the different spaces I found myself. I recall visiting St. Patrick school in Kokstad, a farming community in the KwaZulu-Natal province. This school, funded largely by private white residents, had access to exceptional resources. Although the student body appeared diverse, the teaching staff was made

up of almost all white teachers and administrators with the exception of Black teachers teaching Indigenous languages. Thus, it is unsurprising that in a second-grade classroom, there was a poster of Christopher Columbus "discovering" the United States along with Jan van Riebeck allegedly doing the same in South Africa. Amongst about fifteen posters, I only noticed one that mentioned a Black South African – Nelson Mandela's presidency. I further noticed that in the English classes I observed, students were being inculcated to speak in a British twang that no doubt will signal *smartness* and elevate these student's status in the country. Although this might be on the extreme end, schools such as these elevate whiteness even in African countries that are largely non-white. African ways of knowing continue to be marginalized and this needs to be interrogated in mathematics spaces and other educational spaces. There is a need to return our pre-colonial ways of knowing and learning that centered communities. Essentially, Ndlovu-Gatsheni (2015) pushes for decolonization particularly of education in African societies that enable us to see Africa as the center of knowing and not the west.

In the third and final narrative of this section, youth discuss the importance and salience of elder knowledge in African society using proverbs. Everyone did not have a proverb that immediately came to mind, but I share three in the narrative that follows.

Narrative 3: Elder Knowledge

I grew up on the countryside, so I heard this proverb often as a way to encourage us to stay in school. They say you don't study really well, then you will have been a farmer like their father. So, it's – that's how my parents used to encourage us to go school. Farming is very hard work. Let's say my parents and I do some farm work, for example, transplanting rice, it's very tiring because we have to be in the mud from 7am until 3pm. At the end of the day, your back and

everything just hurts, and you can't stop. So, my mom used to say like yea that's what I told you, if you don't study, you'll end up here.

You know, my mum also said the same thing to me. She always said go to school because I don't want you to end up like me. She would say "chikoro chakakosha" which basically means school is important and knowledge empowers you. I know that comes from her struggles as well as just the struggles that you know many African countries have gone through with colonization in the sense that if God forbid it so happens again right. She also said "Inhlela ibuzwa kwakaphambili" which is emphasizing the fact that in as much as knowledge empowers you, you never take for granted what you're taught by your elders. So, the direct translation is that you ask for the way, you ask for directions from the people in front. I picked that one because it goes back to my picture that I chose the last time that you know, the elderly we kind of forget them, but they have so much knowledge so that statement of saying directions are asked from people in front uhm, I mean yeah, just emphasizes that point and just to listen when you're being told by elders that you should do this.

In my language [Luganda], we say "Kuburiirira" which kind of means the person that listens to the thing is taught. Translation is hard sha but it means something like listen to the wisdom of the people who were there before. But that's the type of education we used to rely on. I feel like was more like, passed down, and it worked, it worked until it was interrupted. Like it worked for, like the older people, they pass it down, and then the younger people passed it down, it was like give you the baton type thing. It reminds me again of Sankofa though. Just the…like looking back to those who were here before us and what they, uhm they brought.

Unpacking narrative 3. The narratives above are all connected to elders in some manner. Mendrika shared her proverb that spoke of the young not ending up like their fathers.

Interestingly, I note a connection to gender in her proverb because presumably, ending up like one's mother is a much better fate than ending up like one's father. Mendrika grew up in a farming community in the countryside of Madagascar, a part of her identity she mentioned frequently over the course of the semester. She explained the arduous task of farming which her mum used as a form of encouragement for her to stay focused in school.

Manyoni's first proverb, *chikoro chakakosha* also emphasized a similar sentiment but her second proverb, *Inhlela ibuzwa kwakaphambili*, states that though knowledge is empowering, one must never forget the knowledge taught by elders. Manyoni also connected this proverb to the image of the three generations of women she shared in the first full session. Embedded in this proverb is a nod to Sankofa as it speaks of looking back (to knowledge learned from elders) before moving forward. Sanyu also shared a proverb, *Kuburiirira,* which holds a similar meaning. *Kuburiirira* also holds elders in high esteem as it asks that we listen to the wisdom of those who came before us.

In the discussion around our mathematics journey, there was no mention of elder knowledge in our mathematics learning. There was also no mention of Indigenous ways of knowing mathematics throughout our education. Drawing on Diasporic knowledge, and Sankofa more specifically, was important as we continued mapping our journeys before seeking to examine a social issue collectively. Njo had volunteered to lead this session around our broad educational and mathematics experiences. As I did in the first section of this chapter, I wanted our original words to be represented as fully as possible in story form so the reader can make sense of it on their own. Nevertheless, I discussed some important themes (gendered mathematics learning, challenging western education, and elder knowledge) in this collective narrativizing.

Unlike the discussion on Africa as a whole that was largely filled with joy and a longing to be back on the continent, the discussion around mathematics learning was filled with sadness, anger, and longing. The gendered experiences of the young women, the impact of colonization on the African education landscape, and the lack of elder knowledge in schooling all gave rise to a somberness at the end of this session. Despite this, there were many instances of disruption at each of the three narratives – gendered mathematics spaces, challenging western education, elder knowledge – as I showed. This continued journey in rediscovering and recovering our past experiences showed that we are all human with full stories before mathematics. In the next section, we go on a journey to consider the Indigenous mathematics knowledge that Africans have had for centuries. Further, we explored what it might mean to bring elder knowledge into our mathematics learning.

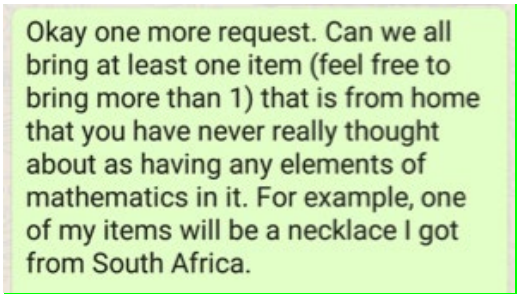
"I Never Liked Maths in School but I Never Knew I Already Knew Maths!": Investigating Indigenous African Knowledges in Mathematics

In writing this section, I note many moments when I drew on the pedagogy of pausing (Patel, 2015) to ensure that I was clear in honoring the various stories shared by co-researchers. This pedagogy of pausing was evident even in the data generation stage, leading to the data I draw on largely in this sub-section. At the start of our FAM session on February 6, 2019, we reviewed the discussions we had engaged in the previous three weeks. Given that we were about to move into the aspect of our work focused on social issues more squarely, I thought it would be worthwhile to engage in a collective remembering of the work we had done together for the prior three weeks. As we revisited our time playing the Lagos version of the board game Monopoly, we recalled our consensus that the Lagos version differed from other versions only in the context of having different cities. The conversation shifted into discussing different game designs we

might offer, including making our game circular and not rectangular. It was then that Sanyu, who had missed the Monopoly session, stated "like there's a saying that wherever you see a right-angle, a white man has been there." She further said, "So like houses, the way we used to build our houses, well I wasn't there, but it's said they used to be circular, round but as soon as the British came, they became right-angled." We remarked at this comment but quickly moved on to brainstorming social issues we might want to examine.

But after the session, I could not stop thinking about her comment as I reflected in my memo. Patel (2015) stressed that "pausing is useful, even necessary, particularly in these modern times in which colonial projects have shaped … deadlines, all competing for our attention" (p. 1). While I had not expected aspects of ethnomathematics to surface in our discussion, as evidenced by its absence in the literature review section of my dissertation proposal, pausing and pivoting the plan for the next FAM session proved invaluable. I asked the group to bring an artifact they had from their countries to our next session (see Figure 9).

Figure 9. WhatsApp text requesting artifacts



I made this decision because of Sanyu's comment about the right-angle being associated with white (colonizers) people. Building again from my ethos to co-learn with the team, I was willing to learn alongside the youth in unpacking Indigenous and embedded mathematics that exists in our communities. There have been critiques, and rightfully so, about the dangers in ethnomathematics objectifying the Other (Pais, 2011; Wolfmeyer, 2017). Like Paris (2019), I

wondered what ethnomathematics could still offer "beyond the white gaze" (p. 218). I contend that eliminating the white gaze (Morrison, 1998) in this process opened up space for co-researchers and me to find an immense amount of joy as we recognized the depth of knowledge in our communities. As I will show in the different narratives, examining artifacts allowed us to discuss practices and ways of knowing that are liberatory for us (Dei, 2002; 2012). Dei (2012) further asserted that "African scholarship, research and knowledge production must help us to recover and reclaim ourselves, our knowledges and our voices" (p. 105) because "Indigenous cultural knowledge is about searching for wholeness and completeness" (p. 112). Thus, engaging in this activity illuminated African Indigenous ways of knowing and thinking that, to co-researchers and me, had only been apparent in school mathematics.

The data I analyzed for this sub-section came from the session when we examined African artifacts to understand the dichotomy between western ways of knowing and thinking and Indigenous African knowledges of mathematics. In many ways, this section embodied FAM fully as we co-learned together, disrupted normative narratives about Africa, and exhibited much joy as we engaged together. Throughout data generation and the six weeks I spent in South Africa, my senses were heightened to connections to this project. One of those connections came from watching Netflix. In the third episode of the third season of the Netflix series, Queer Eye[13] (Collins, 2019), the fab five, as they are colloquially called, visited the Jones sisters in Kansas City, Missouri. The Jones sisters, two African American older women nicknamed Shorty and Little, ran a barbecue business (Jones Bar-B-Q) that needed revamping. In one scene, Antoni, a white man and the food expert on the series took the sisters to a manufacturing company as they

[13] The fab five of Queer Eye take a holistic approach in their work. They work with people to improve their eating habits, fashion, mental health, home design, and personal grooming.

sought to bottle their barbecue sauce to generate more revenue. The following conversation ensued:

Manufacturers: Let's get started. So what goes next?

Little: Put that [brown sugar] in there. Only use half.

Antoni: When you're making this, do you have measuring cups?

Little: No, I got my eyesight

Shorty: We don't measure

Antoni: So, you use your hands?

Little: No, my eyes

Antoni: Okay

I was immediately struck by the overt rejection of measuring that is commonplace in the culinary world. The Jones sisters were unflinching in their responses to Antoni who seemed shocked by their responses. I sense that the Jones sisters were foregrounding a way of knowing that seemed unfamiliar to Antoni and the manufacturers. The type of knowing is embodied likely from maternal knowledge passed down from generations. Antoni, along with the manufacturers, all white men, appeared incredulous while the Black women, with serious expressions on their faces, were unfazed. They did not need to rely on mathematical measurements to create their sauces. They did not rely on the western way of thinking that largely valued exactness.

Committing to Fela's *Teachers Don't Teach Me Nonsense* also meant that I shared my learning with the group as they did with me. Recognizing the short notice, I did not expect everyone to be able to bring an artifact to our session on February 13. Nevertheless, we had enough artifacts to generate fruitful conversation. Sanyu brought a small bowl (Figure 10) from home, while I brought a necklace (Figure 11) I purchased in South Africa and a jacket (Figure

12) I had made in Nigeria. Mendrika brought a comb and binder but noted that though she brought those from Madagascar; they were not locally made. Soro stated that he did not have anything from home. I was surprised by this because I saw him wear many clothes made from Cote d'Ivoire that often have really interesting Geometrical connections. This meant that he did not notice these connections on his own. Njo forgot about the request but proceeded to share three important examples of artifacts via pictures on the internet that she would have brought if she could. Manyoni was absent at this session because of a statistics exam that was scheduled during our meeting time. Thus, we had three physical artifacts with which to engage. To begin, I share pictures of the three artifacts along with a collective storying around each artifact to show how we were able to unpack Indigenous ways of knowing embedded in our communities. Then I discuss the three examples Njo shared via pictures and how she particularly exuded a level of awe and joy leading her to exclaim "Guys, I learned a lot!"

Artifacts Displayed in FAM Session

Below, there are three artifacts that we got to touch physically. The intention behind this activity was to contend with Sanyu's comment about right-angles being so connected to colonization. The mention of a right-angle, a concept deeply rooted in mathematics, prompted me to consider what African Indigenous knowledges we as a group might notice in practices in our communities. Immediately following each of the three pictures, I include a short narrative that captured the conversation as we discussed different characteristics of each artifact. Writing the short narrative using a word or a short sentence per line was parallel to the conversation the was had. By this I mean that during this particular FAM session, we randomly took turns saying what we noticed about the artifact and I wanted to mimic that as well.

Artifact 1: Zigzag pattern in bowl

Figure 10. Small bowl from Uganda

Mathematics

The zigzag pattern

The symmetrical pattern

The length of thread

You don't need to measure

You just know it

When Sanyu showed the bowl, I asked the group if they noticed any school mathematics[14] embedded in the bowl. Njo, without hesitation, stated "there is mathematics." She picked up the bowl and efficiently discussed the mathematics she noted. She focused on the precision of the black thread creating a zigzag pattern on the ball. Njo was intent that "they definitely had to calculate like what length of thread to put in" as they embroidered the bowl. I probed further as evident in the conversation below:

Molade: And when you say calculate, do you think they got out a ruler or they used other means to figure out the length?

Njo: The length?

[14] I use mathematics henceforth, but I refer to the school mathematics taught in formal schooling spaces.

Molade: Hmm hmm

Njo: [Laughs] You don't need to measure. [More laughter] You just know it.

This conversation was reminiscent of the one between Antoni and the Jones sisters referenced earlier. Njo's laughter appeared to express a ridiculousness in my question. It was as if she was reminding the group that these basket weavers do not need to rely on western standardized measurement because their ways of knowing are embodied (Dei, 2012). Underlying her laughter was the connotation that they can "just know" how much thread they would need to create the perfect zig-zag pattern on the bowl. Following this, Mendrika, with a full smile on her face, gleefully remarked that she saw what resembled a symmetrical pattern on the bowl. Symmetry is a core component of mathematics, particularly in geometry, leading the youth to connect these patterns to mathematics. I have had the good fortune to visit several African countries and every community I have visited has basket weavers, who make use of rubber thread, tree barks, and other materials, yet never had I even considered the mathematics implicated in their work. It is quite plausible that these basket weavers have not considered the mathematics in their practice because well, they do not need to. However, recognizing the joy on our faces, particularly on Njo and Mendrika, was a stark contrast from the sadness they exuded when they discussed their mathematics experiences. Thus, I am indicating here that it is not the recognition of mathematics that brought joy, but the realization of the African Indigenous knowledges in these practices.

Artifact 2: Trigonometry in necklace

Figure 11. Zulu necklace from South Africa

I see

Triangle

Circle

A trig function

Waves

Lines

There is a lot of calculation

The collective storying shown above describes the mathematics the group found in this necklace. The intricacies of the necklaces made primarily by women from the Zulu tribe cannot be understated. As is shown above, this necklace is an exquisite display of patterns with the use of shapes (circle, triangle, rhombus) and a variety of colors (red, yellow, blue, green, black, white). The school mathematics seen here ranged from elementary content (counting) to high school trigonometry (trigonometry functions). It is also possible to begin seeing the formation of a Pascal Triangle in the necklace.

Artifact 3: Fabric construction

Figure 12. Jacket fabric from Nigeria

The construction

The patterns

Five, Five, Five

Lots of patterns

I met a tailor

Who never took your measurement

He just knew

They [tailors] might not have university degrees

Yet they are so into mathematics

If I wasn't a tailor, I wouldn't know

Njo engaged in a process of decolonization as she began to question her school learning and the types of knowledges that are valued (Wane, 2009). Mendrika remarked on the repeated patterns she noticed on the fabric and Soro discussed the intricacies of making African fabrics.

He offered that traditionally, fabrics made of cotton are made using hand motions often in a zigzag pattern. Soro, smiling, marveled at how these traditional makers knew when to stop, add a new color, before continuing to make beautiful patterns. He expressed, "just even making the fabric is very mathematical." It should be highlighted that Soro is an engineering major who at the time of this study was enrolled in Calculus III at a university. Nevertheless, he disrupted the notion that those with a high level of mathematics and engineering knowledge are better adept at making these intricate patterns than local fabric weavers. He said,

> Like nowadays, if you give it [fabric] to someone who know math and know engineering and stuff, he will be like, okay, measure and code it and make sure every time it [the weaving tool] goes, if you use this color, change color you know, if like you use like a program to do that but for the person who is doing it is just like, [motions zig zag] change color. So it's [the African weaver's process is] just impressive.

Soro's comparison between the local fabric weaver [who likely has not earned a university degree] and an engineer/programmer here illustrates how he valued that "I just know" or embodied knowledge that is core in African Indigenous knowledges (Abdi, 2002; Dei, 2012; Greene, 2019). This notion of "just knowing" calls back to what the Jones sisters voiced in Queer Eye. In my own mathematics training, it was not enough to just "feel" or to just "see" though these skills certainly help in one's mathematical journey. But "just knowing" remained salient in our discussions and I return to this idea in the subsequent sections of this findings chapter. To preview, my analysis illuminated how youth co-researchers shifted away from *feeling* to *wanting certainty,* which led to the undervaluing of traditional medicine in favor of manufactured medicine.

Artifacts Displayed via Picture in FAM Session

Circular homes. Njo arrived late at the February 13th session. As she got settled, Sanyu updated her on what we discussed thus far especially because she missed the February 6th

session. As soon as Njo shared the comment about the right-angle and the white man, Njo did not skip a beat as she immediately shared about the circular houses that still exist in her family compound. I took a picture of a similar traditional home when I visited South Africa as shown in Figure 13.

Figure 13. Picture of a traditional African home

Though the idea for the circular home arose because of Sanyu's comment about the right-angle, Njo went further to describe the different knowledges that elders needed to have in making certain decisions. For example, Njo shared about the use of the thatch material for these homes (see Figure 12). Njo shared the following with the group:

> Actually we still have those houses. The old women and grandfathers they don't like living in these [modern] houses. My compound still has those [circular] houses…So it definitely came from, I mean interaction with the white for sure 'cause it's not like Africans don't know that the metal is also used for roofing but because like the thatch has a lot more merit. If you look at our environment we have the grasses [that] is cost free. The grasses are also, they are not conductant. They don't conduct heat, electricity…That is one cross of it but like if you look at the conditions at home especially for Sub-Saharan Africa its really, especially year-round, it's really hot. So thatched houses are very conditioned naturally because of the grass. So when people started to build in the corrugated houses using the metal to roof on the houses, like I myself I was a living example of that. Like moving from a thatched house to a metal roofing house. We used to

> say when I was young like this house has burned people in it. Because it's like the metal absorbs heat and in the night it starts radiating [heat] so the room becomes really, really, really warm so people start going into next things. Buying fans, buying air conditioners so the expenses of families increases. I can say like it's a long story. You can say poverty like just starts going from one step to another because family spends more money on things that were never used before like electricity for fans, electricity for air conditioning…I never thought of that but I mean, I knew this was happening at the time.

So much of what Njo said here speaks to the ways of knowing she noticed in the context of building traditional African homes. Njo highlighted the type of "learning" that had to be in place to ensure that elders knew the types of materials necessary to keep homes cool. She pointed out that the use of thatch as opposed to metal for the roofing was a deliberate act because they studied their environment. Boutte, Johnson, and Muki (2019) corroborate Njo's claim as they stated that "African indigenous people's intimate understanding of their environments led to the development of medical breakthroughs and innovations" (p. 20). Njo, disrupting the "illiterate" narrative about African elders, highlighted their knowledge in recognizing the non-conductive nature of grass compared to metal. Because of the abundance of grass, she spoke of the cost-effective nature of using grass or thatch for the roof of homes. This material also allows the home to feel cooler year-round, making it more bearable. Moreover, in under three minutes, Njo articulated the implication of changing the building materials which has given rise to fans and air conditioning and has added more costs for families. While in South Africa over the summer, I spent some time in circular mud houses, called Rondavels. Though they were more updated than those found in more rural communities, I felt the warmth and the rich earthy smell that cannot be found in modern-constructed [read *right-angled*] homes.

It is difficult to unpack the application of decolonial theory and the various decolonizing frameworks that are present in the vignette of the circular home because they are intertwined. First, our being together and collective learning was guided by Ubuntu. Next, our heeding to

Sankofa pushed us in considering our own educational experiences which led to the comment Sanyu made. Thirdly, engaging FAM pushed us to be comfortable disrupting colonial narratives and interrogating the exclusion of African Indigenous knowledges in western [colonial] education. Njo challenged the "coloniality of knowledge" (Ndlovu-Gatsheni, 2015) as it became evident that she foregrounded types of knowledge that to her, are legitimate and educational. Essentially, Njo (and the rest of us) shifted towards "epistemic freedom" (discussed in Chapter 3), as she is emerging with what Ndlovu-Gatsheni (2015) termed critical decolonial consciousness; that is, she was aware not only of multiple ways of knowing, but she was also upholding all of these ways of knowing as valid. This process was invaluable as it allowed her open space for possibilities in the context of mathematics as I show in the next two sections.

Traditional boat. Njo shared three other artifacts with the group, the Kora (a locally made musical instrument), a traditional boat, and a kite as all being embedded with rich mathematics. I focus here on the traditional boat (see Figure 14) as this conversation generated some important mathematical connections.

Figure 14. Traditional boat from The Gambia

I share a part of the conversation that ensued below:

Njo: I mean still now most of the boats we have in rural parts of the Gambia are made by men like themselves. So they just go into the forest and they know what to use…So I was thinking like how did they know the density of water and how did they know the density of those timber and they make sure that they use a type of wood that would not, number one it will not disintegrate early and number two, it will float on the water. Like how did they measure that? It's like they don't have any machines to measure which wood is compatible with the water we have the density of water but they are able to like make boats that would like transport them from one part of the country to another. Like these are local boats like wood.

Molade: Are they doing mathematics?

Njo: They are of course! Like, we've talked about this. But they are because the boats if you see them they're usually like this long elongated boats and so you don't usually sit on it in a particular way. There's a specific way you'll stand on them and that is a measure of balance.

Mendrika: Centroid. That's maths!

Njo: Yes! So if you see the way the boat men stand, those people have already, oh my god yeah!

I will take a moment to pause here as I recognize that my questioning was focused on mathematics explicitly. I wish now that I asked more broadly what other knowledges we thought was evident in these practices. I recognize that in some ways, my focus was on mathematics particularly because of the right-angle comment Sanyu made. At the end of this exchange, Njo exclaimed "oh my god, yeah" because she was surprised that she had not thought about the mathematics embedded in the making of these traditional boats. I asked if she thought they were doing mathematics because she had made a connection between the traditional homes and mathematics. As Njo considered the way these men have to stand on the boat in order not to fall, Mendrika chimed in saying this was essentially the geometric (and physics) concept called centroid. Njo also noted mathematical applications as she discussed the density of wood and

water. Mendrika, gleeful with excitement, later shared that she was learning so much in this discussion. Mendrika further insisted that there was a problem in not recognizing the knowledge used in creating these boats in what is considered formal education. Without an understanding of the practical knowledge the Gambian men used in making these boats, Njo recognized that it was much more than simply common-sense knowledge which I will discuss in a subsequent section.

While Sanyu's comment on the right-angle might have seemed unimportant in that moment, it led to many moments of joy as we recognized the knowledges in seemingly simplistic artifacts we had not previously realized. My goal in this dissertation had no connection to ethnomathematics in its original conception but centering frameworks that foregrounded co-learning allowed this deep learning to arise.

Decolonizing our Mathematics Knowledge

Njo repeatedly expressed joy around the new realization she encountered as we deconstructed the mathematics that existed in our communities. She exclaimed, "I never knew that I already knew maths in my own way." Njo showed the power of Ubuntu and FAM as she realized her ability to disrupt and rewrite false narratives about mathematics and mathematics learning for Africans. In the first section of this chapter, I reported how Sanyu commented about the ways colonization attempted to disrupt our abilities to see our value and worth. Njo expressed similar sentiments as she discussed why artifacts such as the ones shared were not evidenced in our prior mathematics learning. She said, "It was all planned…sort of extracting that part of us like without even us knowing what was going on." Njo recognized a distrust in the system that distorted the mathematics knowledge that has existed in our communities for a long time. She felt that the informal mathematics people used from a young age when knitting a handkerchief, creating designs on bedsheets, or making other artifacts should have been characterized also as

relevant mathematics. She thought such recognition of these kinds of activities or practices would have given her the confidence she needed in her formal mathematics education. When Mendrika added that in many ways, this informal type of mathematics knowledge was considered "common sense" knowledge, Njo was alarmed. The following conversation ensued:

Mendrika: Like before, there were no architects. There weren't any official architects, but people actually knew like they say you should face your house this way because you would get sun and let's say if you put your house here, there will be some run off when it rains. And then this part can go to your house and that'll make the foundation weaker. Something like that. Yeah, it's like, just common sense. I mean, I'm sure okay.

Njo: Okay that common sense, let's talk about it. I mean, that common sense. Okay this is how I'm seeing it. Like most of these concepts that we have, they actually been ingrained in us like, you know, in our school systems like I wouldn't call that common sense like building a house like trying to see the topography of where you're building your house, because that involves a lot of like, a lot of internal thinking for the person who is trying to construct…Because I know there are mountainous areas where people are able to build houses. Okay. So if somebody is trying to look at the run off, and also the topography of where they want to build their house, they definitely will have to look at how much run off do they have and what materials they are going to use for the houses because there different types of materials you can use to make your house more fortified and all that. So I think there's a lot of thinking. I don't think it's a common sense. But the people that built it, they had a lot of knowledge, right, that's what I'm looking at. They probably had a lot of knowledge so it was not like common sense to them, they knew what they were doing. They were their own architects.

Mendrika: So where did they learn that?

Njo: Because, okay, let's talk about this, the people back home, our ancestors actually were… Let's not talk about literacy and illiteracy again [see Narrative 2: Challenging Western Education] because those are, those are words that we just took, I mean, we just consumed them like that. But I would say these are people that were living with so much wisdom…So people have at home those days, they were exposed to the nature like they were living in the nature, they were around jungles. So they had to think of

> ways to survive. It's just a natural thing for human beings to just see the environment and tried to interact well with their environment to survive. So I believe due to that interaction, they had their own school and that was the environment. This was how they learned and they learned things naturally and originally so when there was an interaction from outside world, their knowledge was pressed on and this was how we lost all those great people… Is like they lived in an environment before where nobody tampered with so they had to find ways to make their environment usable and also friendly to them. So they learn all those things from their own hands and their own ways. I think they are very, very, very smart people. very intelligent like. They didn't just have classrooms as we knew but like they were teaching their kids like they were teaching their children okay…Cooking itself has a lot of mathematics at home. Like cooking rice without measuring the cup, the cups you put in your cooking pot and making sure that that rice cooks well in that water like that is a lot of calculation…When it comes to the men, with the construction, the thatched [roof] of the house…they have to know the circumference on top and now they go find the grasses. The grasses have to be shaped in a in a way that it will cover the circumference and totally like it will not sink in. So there's I don't know, like, I'm just realizing that I never really really thought.

Njo again makes multiple connections to embodied ways of knowing that are rooted in African Indigenous knowledge (Dei, 2012). For example, she felt that there was knowledge that was "ingrained in us", which she rejected as "common sense" knowledge. To Njo, common sense felt lesser than formal [e.g. school mathematics] knowledge; a binary she opposed. Njo discussed the knowledge needed in knowing the topography of an area before building a house in a mountainous area. She gave that example to illustrate that Africans had an in-depth understanding of their environment, thus, were architects in their own right. She rejected the notion of illiteracy because as she alluded, Africans were expected to "consume" colonial education. Instead, Njo rejected deficit notions of African Indigenous ways of knowing particularly as she connected this to the knowledge of environment; another aspect of African Indigenous knowledges (Dei, 2012). She referenced that they learned from their "own hands"

and “own ways” that existed before colonization. Njo pointed to the fact that this rich knowledge often goes unacknowledged, a point made by other African scholars, too (Abdi, 2002; Dei, 2002; Wane, 2009).

I once more pause to consider the following: How can [African] mathematics curriculum connect the knowledges that go into constructing the thatch roof of a home to school mathematics? What does it mean when Njo asks her mum how she knows how much water is needed to cook rice and her response is “I just know?” That is, how can African Indigenous knowledges be brought into school mathematics in ways that do not denigrate Indigenous knowledge? Mendrika began to answer this question. She said,

> That’s very interesting. Actually my dad didn’t really go to school as much as my mom. But I see my dad as like he’s an engineer and I don’t know. Because it’s like when we build like, let’s say, when my mom and my dad built our house, it was just my dad who made the architecture and then what surprises me the most was when we made our gates, uhm it was him who designed the gates and like I don’t know. I couldn’t even imagine that like my, I was just so surprised when my dad showed it to me. Like wow, I can’t do this because it’s like it looks as if he was like, actually a professional architect. And I’m just like, oh, I’m never underestimating him because even if, let’s say he didn’t go to school as much as other people, actually it’s like, as you said, like it’s just like in people…They don’t even have to have a lot of knowledge to actually do things that other people who go to college [can do].

Although we probably would all agree that there is a lot that we do learn in formal education, Mendrika’s line of reasoning showed how to both appreciate the formal education we receive while also recognizing the ways our elders have lived and managed their communities despite their not having “a lot of knowledge”. Building co-learning and Ubuntu as core components of the research space enabled each one of us to grapple ideas with and from one another. It allowed Sanyu to tell Njo “I have learned so much from you,” and created space for each of us to interrogate the disconnect between school mathematics and African Indigenous knowledges.

In the previous section, I discussed Sanyu's negative experiences in her secondary mathematics learning. After noticing the many ways mathematics was a part of our communities using the various artifacts, Sanyu shared,

> So I feel like they [colonizers] take things like math and make them so fancy and complicated that when they sell it back to us, we feel like we don't own it. And yet to be honest, in our backyards, we do more math…but like they [the west] are being sold back to us for expensive…It's [maths] not sold in a way that we can consume. Like if it was sold to us by our own teachers who are not educated by white people, we probably could have consumed faster and have been even better than the entire world.

Sanyu is pointing to the way western mathematics is "sold" [connecting this to capitalism] as the "legitimate" mathematics in African communities. I am reminded of Ahmed's (2002) observation that "the West takes, then gives, and in the moment of giving repeats as well as conceals the taking" (p. 22). Sanyu is making many points here that decolonial theory allows me to parse out. First, Sanyu is once more challenging the center of knowledge that has been privileged for a long time (Ndlovu-Gatsheni, 2015). She is arguing for a shift to center African contexts. Although I believe that many teachers are now educated in their own [African] countries, Sanyu's statement about teachers being educated by white people calls back to the residual impact of colonization across many African school curricula (Dei Ofori-Attah, 2006; Okoth, 2012). Sanyu is also addressing the importance of culturally sustaining mathematics for Africans. She stated that there is already "math in our backyards," but this mathematics is not readily apparent to people. Adding to this point, Soro implicated the problematic practice of using western textbooks that discuss contexts that are foreign to many African communities. He further noted that it becomes difficult to learn a subject if "you can't relate to what you are learning."

It is apt to end this chapter with Fasheh's (2012) words that I shared with the group at the end of our discussion uncovering the mathematics in the various artifacts shared. Fasheh is a Palestinian mathematician and has written extensively about the destruction caused by his western mathematics knowledge as compared to the richness of his uneducated [in the colonial sense] mother's mathematics (Fasheh, 1990; 1997; 2012; 2015). Though he is not African, his Palestinian roots speak of historical and current experiences with colonization. He wrote,

> The kind of mathematics I studied and taught was more in line with the values of greed, power and control. While my mother's mathematics was embedded in life inseparable from it … It took me several years to realize that my mathematics and my mother's mathematics do not intersect; they belong to different worlds…What made things even more shocking was my realization that even if I studied mathematics for another ten years in universities, I still wouldn't be able to do what she was able to do without being taught and without curriculum, tests, and grades! … In contrast to my mathematics, which was aloof, my mother's mathematics was embedded in life like salt in food; we can taste it but not see it. It was useful, beautiful, meaningful and fitting; no woman would have accepted a dress if it lacked any of these qualities. Her work was not only of art but also constituted of main scientific aspects: experience, observation, experimentation, and making sense. (Fasheh, 2012, p. 93)

When I shared Fasheh's words with the group, there were head nods, snaps, and yes's because it encapsulated the discussions we had. In the next two sections, I share the participatory action research project co-researchers and I embarked on for three weeks.

"As Africans, We Have Our Own Ways That Our Ancestors Healed People": The Beginning of Our Participatory Research Project

In the Summer of 2009, I was preparing to begin the second year of my master's degree in applied mathematics in Conway, AR. That summer, I was looking for a new roommate and found a white woman, from Arkansas, who seemed pleasant. It appeared that we had good chemistry so I was surprised when I did not get confirmation that she would like to live with me. After some time, I called her to inquire and she responded sharing that her parents were worried about her living with an "African" because of perceived diseases I might have. I was stunned. I share this story because much of what we shared in our FAM sessions leading up to the social issue we chose to study had to do with healthcare on the African continent.

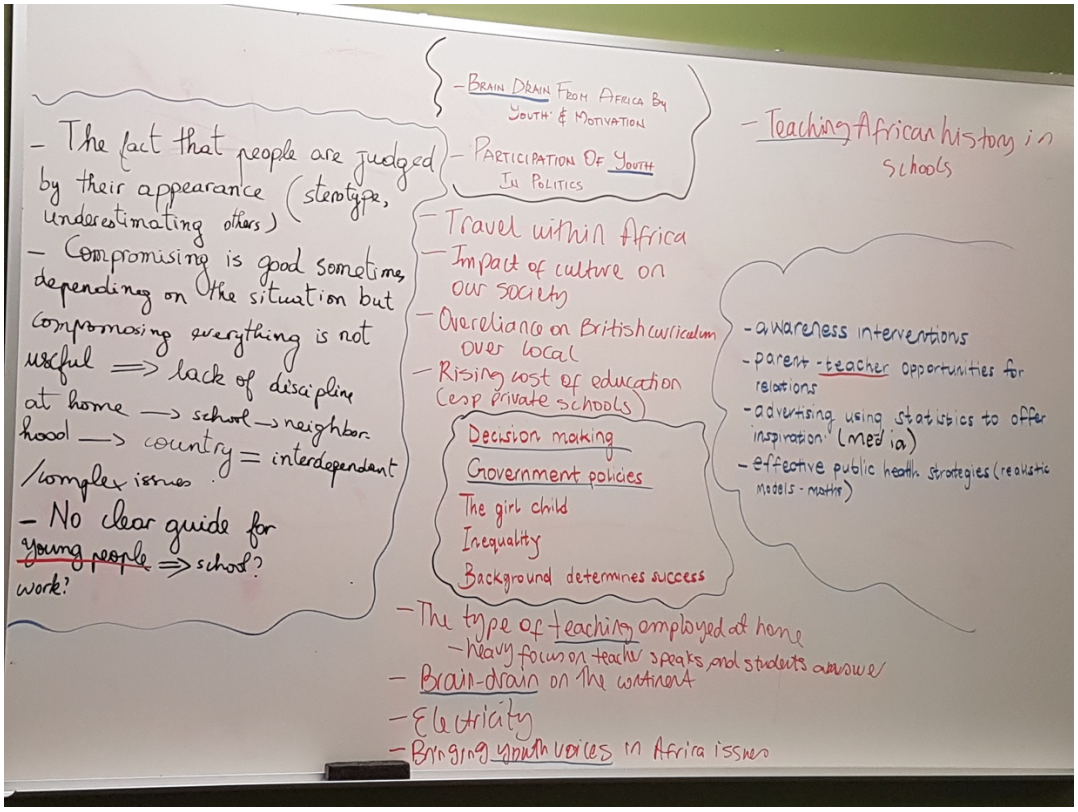
I contemplated how to structure this section because I was concerned that sharing so much detail would be deemed "not-researchy" enough; however, I decided to share these details because they illuminate the process co-researchers and I underwent in co-constructing our participatory action research (PAR) project. I write about the initial set of social issues the group shared, along with our process of refining these issues. This process is an essential aspect of PAR as it shows the co-construction that occurred throughout. I note here that my goal in this dissertation was not explicitly on the research that we conducted in understanding this social issue. Rather, I sought to explore the knowledges co-researchers drew on as they engaged in this exploration, and the math knowledge (if any) that they drew upon in this process.

Building with our Broader Community

At our February 6th FAM session, we spent some time brainstorming social issues we could investigate. Everyone was present except for Njo. Soro proposed that we all take some time individually to write ideas so we could have a diversity of issues as a collective. As we

wrote, Mendrika requested that we play Azonto, a popular Ghanaian song, in the background. After about ten minutes of individual writing, we each took turns writing our ideas on the whiteboard at the front of the room. The initial ideas discussed are shown in Figure 15.

Figure 15. Brainstorming social issues



After writing these on the whiteboard, Sanyu led the group in conversation around the common themes we noticed. In our discussion, we noticed common trends in the social issues we wrote such as young people/youth, brain drain, and teaching. Given the diversity of the issues we raised, I thought it would be worthwhile to discuss a collective understanding of what we meant by social issues. Sanyu defined social issues as "issues that affect the social" which made everyone chuckle. Nonetheless, Mendrika pushed further as she asked, "but aren't all issues [ones] that affect society?" This was an important question and I added that I considered social issues as those that impact a substantial group of people. While I was committed to removing

researcher/participant roles, I recognized as I watched our discussion that there were instances where I could have taken more time to pause to make room for other voices.

Mendrika also added that perhaps the set of issues we wrote on the whiteboard were also issues that were complex to understand from a singular viewpoint. I was grateful that we had this conversation as it was necessary to build a collective understanding of social issues as we proceeded in subsequent FAM sessions.

Building with the ethos of Sankofa (looking back before moving forward), I asked the group to bring, to our next FAM session, an example of an African who had contributed to positive social change in a community on the African continent. This sharing would allow us to look at how other Africans had engaged in similar work with a focus on highlighting what they tried to disrupt. This also connects to Ubuntu and FAM (co-learning) as we were learning in community with those who were equally working to redress social issues in Africa. I shared the following with the group,

> I'm not a teacher in this space but something that I thought would help even me because I haven't done this assignment is to think about, is there someone that comes to mind or it could be an individual or group that we know of, in our, I'm going to say our contexts, I don't just mean in our own countries. But ideally, someone that is African that has tried to tackle an African issue. So a country, in multiple countries or across the continent. What was it that they tried to do and what did they do? What was the issue that they try to disrupt?

I shared the example of Wangari Maathai, a Kenyan conservationist, who put her life on the line to protect trees in Kenya. Her valiant efforts led to her being the first African woman to receive the Nobel Peace prize in 2004 for her contribution to sustainable development. I also shared the example of William Kamkwamba, who invented a windmill, using scraps, during a severe famine in his rural community in Malawi. The second example was particularly timely as a movie, *The Boy who Harnessed the Wind* (Calderwood, Egan, & Ejiofor, 2019), based on

William's life was premiering on Netflix two weeks from this date. Although I felt like I was "teaching" a little too much at this stage, I did believe that it would be helpful to give examples of an older woman and a young man particularly because of our deference to elders and centering youth voices early on. I further asked us to consider the role of disruption in FAM as we considered the issues we wanted to examine.

Engaging Sankofa, Ubuntu, and FAM

At our February 13th FAM session, we shared the examples of the different African change-makers we found that call attention to the interplay of decolonial theory, Ubuntu, Sankofa, and FAM. Unfortunately, Manyoni was absent and Njo did not have time to find an example to share with the group. Thus, we had four examples from Soro, Sanyu, Mendrika, and me. Sanyu was particularly excited to share because she felt that she otherwise might not have encountered the example she found if not given this opportunity to go searching. Of the four examples shared, two centered youth while two focused on environmental sustainability. Sanyu shared about Emma Naluyima, a Ugandan woman, whose work on agriculture entrepreneurship helped to combat youth unemployment. Sanyu shared a few minutes of Emma's talk with us (TEDx, 2018). Sanyu was particularly animated as she discussed Emma because she saw an individual who used agricultural education in ways that allowed young people to "change their world."

Similar to Sanyu, I shared about Abisoye Ajayi-Akinfolarin, a Nigerian woman teaching young girls to code (CNN Heroes: Makoko Fresh, 2018). Abisoye, who was honored as one of the 2018 CNN Heroes sought to interrupt the lack of women in technology in Nigeria. Moreover, she used her girls' coding program to combat gender-based violence and poverty in Nigeria by providing space to occupy these young girls' time and giving them tools that would be useful to

generating income. I noted how Abisoye explicitly stated her intent in allowing the young girls to use coding to begin to address issues in their communities. Mendrika shared about a mayor in Madagascar who used his earnings to provide a small tree for every primary student to plant. Mendrika explained that the mayor was disrupting the lack of trees in the community as many people had begun burning trees or not caring properly for trees. Similarly, Soro's example also addressed tree planting. He shared about Yacouba Sawadogo from Burkina Faso who, after retirement, went on to plant trees across the country. According to Soro, Yacouba was able to transform a desert vegetation into a thriving, fruitful land. These contributions led to many accolades, including the alternative Nobel Prize. Though Soro did not mention this, my own research also indicated that Yacouba centered "Indigenous and local knowledge" in his efforts (The Right Livelihood Award, 2008). Soro posited that Yacouba was attempting to disrupt environmental issues and to teach the youth that "if I can do it, you can also do it."

Across our examples, the group noticed the commitment to addressing social issues within communities that also engaged community members. Though this goal mirrors that of CME, there was no apparent direct connection of the use of mathematics across our examples. Moreover, the goal of these issues was not to expose people to issues of injustice but rather the individuals saw an issue and took action. I was particularly struck by the examples Soro and Mendrika shared because it connected directly to our discussions about the Baobab tree early on. We also saw evidence of these connections when Soro, Sanyu, and I watched the movie based on William Kamkwamba's story referenced earlier. When we shared our reactions to the movie at the February 13th FAM session, Sanyu mentioned the following, "it was so amazing and it kind of like, it really just showed the heart behind even the work that we're doing … The fact that it was a little boy that did this challenged us more even."

One of our main objectives at this FAM session was to try to narrow down the social issues we had written collectively in our previous session. I typed up the ideas we had drafted on the whiteboard into our collective document. After deliberating on how to proceed, Sanyu recommended that we each pick one of the ideas in our brainstorm and write our names by the issue. In addition, I asked that we also include a question that we thought was important related to the issue. I show in Table 5 the issues selected along with the respective questions:

Table 5. Social issue identification

Name	**Social Issue Picked**	**Question**
Soro	Brain drain of youth from Africa & motivation	How to make Africa more attractive to the youth for them to invest in the dream of a better future?
Mendrika	Teaching African history in schools	What is the importance of knowing history in guiding young African? Or, why is it important for young Africans to know their history before moving forward? (values of community and country and continent pre-colonization)
Molade	(Visa) Travel within Africa	What are the challenges Africans face when traveling to other African countries?
Njo and Sanyu	Effective public health strategies	What public health tools do Africans use in surveys and census? Are these realistic to African health context, are they reliable and who conducts them? What ways do the public get feedbacks or understand the results and implications of public health activities?
Manyoni	[Does] Background determines success	Does one really fail if they choose an arts background? Does maths really guarantee your success? If we were all exposed and had the opportunity all equal would that guarantee success?

Afterward, I worried that these issues were enormous to investigate and wondered which of these we would settle on. Moreover, it dawned on me that I had not seen issues like these mentioned in prior research concerning mathematics and social justice. Some common examples in the literature are racial discrimination in housing, driving while black/brown, or the prison industrial complex. These issues tended to highlight the gross injustices facing minoritized communities. I noticed that in the context with co-researchers, the lens at which they were approaching these social issues was on showcasing strengths and not limitations. I explore this some more in the next sub-section of this chapter.

Despite the fact that I had a goal for this dissertation, I felt it necessary to ask the group if they were still interested in pursuing the second phase of this project. That is, I wanted to make sure that they were still interested in investigating a social issue more deeply and proposing solutions to the issue. Everyone agreed it was worthwhile and Njo and Soro shared that they were particularly invested because they wanted to be prepared to analyze issues when they went to their respective countries for the summer 2019 break. Njo stated,

> So I think I mean, I'm down for it because this will help me better prepare for anything that I will do back home. I mean, as much as they [the issues] might not be very applicable because whatever ideas you put in might be from our environment right now. So – but I think it's worth the while to study them and see what suggestions we can come away with. That would benefit us in one way or the other.

Njo was astute in acknowledging that our research might not be fully representative of our communities given that we were all situated in the United States at the time. Soro added on with the following,

> And I also think like you [Njo] said, we are not home so looking at this issue, give us the framework of how we have to do. I don't know we need something to look at when thinking about [our story]…we can look at it as math, how it links back to Ubuntu and stuff like that.

Soro noted his desire to connect the first phase of our FAM sessions (examining our prior backgrounds) to a more tangible issue of focus. He is also showing his embracing of the frameworks as he addresses the role Ubuntu might have in our investigation.

As I wanted to ensure that this research was an emotionally felt experience and not just cerebral (Ngugi wa Thiong'o, 1986), it was worthwhile to learn why everyone picked their respective issues to help the group understand why these issues resonated with them. I analyzed these issues using my decolonial theoretical lens specifically deconstructing the connections to Ndlovu-Gatsheni's (2015) coloniality of power, being, and knowledge discussed in Chapter 3. Across all these was a strong desire to rewrite the stories told about the African continent, which I further expound in Chapter 6.

Coloniality of power. Coloniality of power questions global (western) powers that push aside victims of colonization (Ndlovu-Gatsheni, 2015). Sanyu, for example, shared about her reasoning for choosing a public health social issue. She shared a dehumanizing experience she faced at a conference in 2018:

> So in the summer 2018, I attended the One Health World Congress in Canada, okay, really it was just about health and like, you know, simple things. Not simple things. Things like why children were dying and we got to this point where a Swedish research scientist was talking about how Africa was trying to come up with African CDC and then he laughed. And this was in a science policy room…And one of the reasons that they're laughing at it was like how? Do they even have the resource for it? What mitigation strategy? And that was really embarrassing because we were like about three, four Africans in that particular room. Those other Africans were people who have been working for years, you know, and it was just degrading and were just so embarrassed. Every time an African went up there to present about public health, they were just looking at them like they have nothing. You know they have no strategy that is African…So finding a way for ourselves that's not dictated by foreign aid. And there's a lot of Ugandan kids that are dying because quote, unquote, aid. People come from abroad, pretending to be organizations to help the poor, not competent at all but like they're just trying out stuff on African kids and kids are dying and stuff. So I feel like uhm, it's a real big issue because, you know, health is on the forefront in the world.

Sanyu's experience at this conference enraged every one of us. The view that Africans have nothing to bring to the fold when it comes to creating solutions to our own issues is frustrating. Sanyu rejected the notion of Africans being positioned as invisible or put in the "zone of none-being" (Ndlovu-Gatsheni, 2015). Though Sanyu did not mention this, I imagine that the Swedish research scientist was a white man. His immediate reaction was to denigrate Africans for wanting to find solutions to their own problems. Moreover, no one called this research scientist out on how disrespectful this was to the African delegates in (and out) of the room. This type of remark shows the importance of recognizing the past and present impact of colonization. Sanyu's last remark about the impact of aid spurred a conversation around public health on the continent.

I spoke of my experiences traveling within the African continent and the challenges I encounter, which are unlike those with non-African passports. I shared the following,

> And I think so I'm not even speaking at trying to go outside of Africa. Like, within our own continent, I started thinking about this when I will travel with other like some of my American friends who worked at ALA and we're trying to go to whatever country it is and you, you can enter free and me I have to go through all this trouble, on my own continent. And so I think I like so it's honestly very, it's very personal for me, because I not just that I love to travel, but it's really I really want to see and visit more African countries and just the struggle to get like in.

I shared my desire to visit African countries but the incredible difficulty I face as an African. As I prepared to co-lead the study abroad to South Africa, I needed to apply for a visa both for South Africa and Lesotho. The nine students and faculty on the trip were all U.S. citizens who simply needed to purchase a ticket and show up at the airport. I had to cut a professional conference short to go to Chicago to apply for my South African visa. I incurred almost $400 in related fees and it took an emotional toll on me. The mental exhaustion along

with the amount of time spent in logistics was unquantifiable. Upon landing in South Africa and Lesotho, I took significantly more time at immigration that the U.S. citizens on the trip. Since Lesotho is only a short drive from South Africa, we drove there. At the border, everyone simply showed their passports at the entry point while remaining in the van but I, the only African on the trip, had to leave the car and enter the office. Using Sanyu's words, it was degrading. Across both narratives shows a questioning of western power or the remnants of colonization that caused the creation of borders.

Coloniality of being. Coloniality of being challenges the "continuing struggles in Africa focused on resisting objectification and dehumanization of Black people" (Ndlovu-Gatsheni, 2015, p. 490). Njo was particularly fired up as she remarked about the Ebola and the AIDS crises on the continent which she perceived to be a result of the devaluating of African lives. Thus, Njo's motivation came from a desire to see African life as valuable as any other human. Njo share:

> And so during that time, I was doing some research because I was always not trusting of people, I mean, western technologies I don't trust them usually in African soil…So there was this time when Ebola started in West Africa. And so during that time, I was doing some research because I was always not trusting of people, I mean, western technologies I don't trust them usually in African soil. Like whenever something happens like that, like an epidemic just pop out from nowhere, I start asking questions, like this is definitely from, it's not definitely from Africa. It is somewhere and they brought it in some kind of like a bottle form and it just busted out this way.

Njo claimed that health outbreaks like the more recent Ebola crisis did not originate on African soil. To her, the virus was brought to the continent by outside forces because as she noted, epidemics do not arise out of the blue. While the transmission of epidemics can grow at an exponential rate (writing this as the world is currently experiencing the COVID-19 pandemic), Njo believed that there are forces that have targeted Africans in particular because their lives may

not be seen as equally valuable. She also shared with the group that her research further revealed that the AIDS epidemic was also brought to the continent in a vial that accidentally contaminated people. Although I cannot claim that this declaration is accurate, the underlying feeling in Njo's stories was her distrust of western systems on our continent. Recently, two French doctors spoke on a news segment on their desire to test COVID-19 vaccinations first in Africa (Alouane, 2020). This horrific proposal was quickly denounced by the head of the World Health Organization (WHO), Tedros Adhanom Ghebreyesus who declared, "Africa cannot and will not be a testing ground for any vaccine … And the hangover from a colonial mentality has to stop" (Kenny, 2020). Though the WHO condemned this news segment publicly, it is understandable why Njo feels a strong distrust of the west. Njo believes the public health sector should be a sacred sector across the continent:

> I think the public health sector should be one of the most sacred sectors in every country in Africa. Like this should be a very, very, very pure and purely African run organization, in every country because like they're the ones that receive this people, when they come into the country. They are the ones that received the vaccine boxes. They are the ones that reach the communities directly. The public health sector in my own community, like they come to the villages, they come to the towns with their cars, and they come to household by household and they make sure like they interact with every children…So if children start getting diseases that we have never had in Africa and just like that, I seriously don't know how it happens…but they're the ones that bring the outside world to us like directly in terms of help so I don't really understand so I mean, this is a very social thing. The questions they cannot be exhausted to be frank but like things with tools that they use, like if they are African-based and if they are African empowered, that would be helpful.

Njo is advocating that public health sectors on the African continent should be run by Africans particularly to protect the vulnerable that they come in contact with. Njo's sentiment about the public health discourse on the continent was not in isolation as Soro and Sanyu also nodded vigorously in agreement.

Coloniality of knowledge. Lastly, coloniality of knowledge challenges the "assymetrical" nature of knowledge production (Ndlovu-Gatsheni, 2015, p. 490). Soro's reasoning for choosing his social issue also came from a desire to center the knowledges of Africans within Africa. Soro was interested in considering how to make Africa more attractive for youth to reduce the impact of the brain drain that is currently plaguing the continent. He shared,

> And I know for sure, there's no opportunities that can keep me here [in the United States]. So I'm like is just because when people look at Africa there is not opportunities, it's not really attractive. And I don't know was it last spring when the African bank president came here. Like they're trying to make agriculture attractive to young people because that's like the force of Africa. So I feel like we just need to find ways to make things attractive in Africa, make business attractive in Africa, make agriculture attractive to people so that even if you went to school and get your [degree], you can come back and be a farmer and create innovation.

Soro's motivation, rooted in Ubuntu, is to ensure that young Africans embrace the opportunities and values in contributing to the African continent. Mendrika was also motivated to understand to what extent African history is taught in schools across the continent because of her family's valuing of their history. Mendrika believed that our knowledge of African history was deeply impacted by colonization. She shared,

> I mean, like when, when she [her aunt] said the history, more importantly, the value of the community or the continent, even, let's say before colonization, because colonization just destroyed many things especially the culture and people just lose their value.

Using an African decolonial theoretical lens along with the African frameworks also reveals a commitment and dedication to African communities along with a desire to highlight the wealth and strength of our communities. Because we were approaching the middle of the semester, we had to decide on one issue quickly. We engaged in a spirited debate about how we could vote. During this discussion, Mendrika and I decided to take our own social issues off the table, leaving three left. I requested to abstain from the voting process but was quickly told that I

was a part of this process, thus, my vote equally counted. Soro and Mendrika took charge of the voting process and we ended with Sanyu and Njo's social issue: Effective public health strategies.

This section highlighted the importance of understanding the commitments involved in the participatory research with the group of African youth. Though this section did not speak to the role of mathematics centrally in these contexts, my intention was to show the social issues discussed were undergirded by [African] decolonial theory, Ubuntu, Sankofa, and FAM. In the next penultimate sub-section of this chapter, I will flesh out the focused exploration co-researchers and I embarked on.

"Data Is Like the Most Effective Way": Exploring the Role of Mathematics in Social Issue Research

This section focuses on the specific research Njo, Manyoni, Mendrika, Sanyu, Soro, and I worked on related to effective public health strategies. I recently watched the film *Dark Waters* (Ruffalo, Vachon, Koffler, & Haynes, 2019). and throughout my viewing experience, I was reminded of many of the sentiments expressed in our FAM sessions around the distrust of the pharmaceutical industry. In *Dark Waters*, the audience learns of the vast injustice dealt by the chemical company DuPont to a rural West Virginia community. I include this movie to highlight the relevance of the social issue we studied. In this section, I will discuss how we chose a focal social issue within public health and our collective process in gathering and analyzing data. Recall again that my goal is not to go into detail on the "research within a research" that we conducted. Rather, I focus on exploring the knowledges that they drew upon in this process. I also focus on answering my second research question: when and how do Sub-Saharan African

youth draw on mathematics, broadly, to understand and to disrupt social issues? How do they view the role of mathematics in disrupting these social issues?

What Are We Disrupting?

Disruption is a key aspect of FAM (described in the methods section), as Fela was clear in naming all of the issues in the Nigerian political system. Thus, though our group had agreed broadly on a social issue – effective public health strategies – we needed to be more focused on what aspect of public health we needed to disrupt. At our March 13th FAM session, I said "maybe a good way to go about this is to discuss what it is that we want to…" but before I could complete my sentence, Sanyu chimed in spiritedly with "…disrupt." This assured me that we were committed to our guiding frameworks, in this case FAM.

Since this particular social issue came from Sanyu and Njo, they instinctively took the lead in this discussion. This "instinct" came about because I was aware of my positioning in the group and was consistent and persistent in discussing the co-learning and relationality of our space. Njo asked if anyone had experiences with the public health departments in their communities, which led to conversation around manufactured medicine as compared to traditional medicine. In defining manufactured medicine, we referred to medicine that has been produced in laboratories and generally sold by pharmaceutical companies. On the other hand, we viewed traditional medicine as that which is locally sourced and unrefined. For instance, utilizing herbs, or a tree bark which called back to the Baobab tree. Throughout the conversation, there was a recurring theme on the importance of elder knowledge in our African context. For instance, Manyoni noted that "as Africans, we have our own ways that our ancestors healed people." Another recurring theme was distrust in the west particularly as the west has historically and presently pillaged the African continent. In the same conversation, Manyoni expressed her

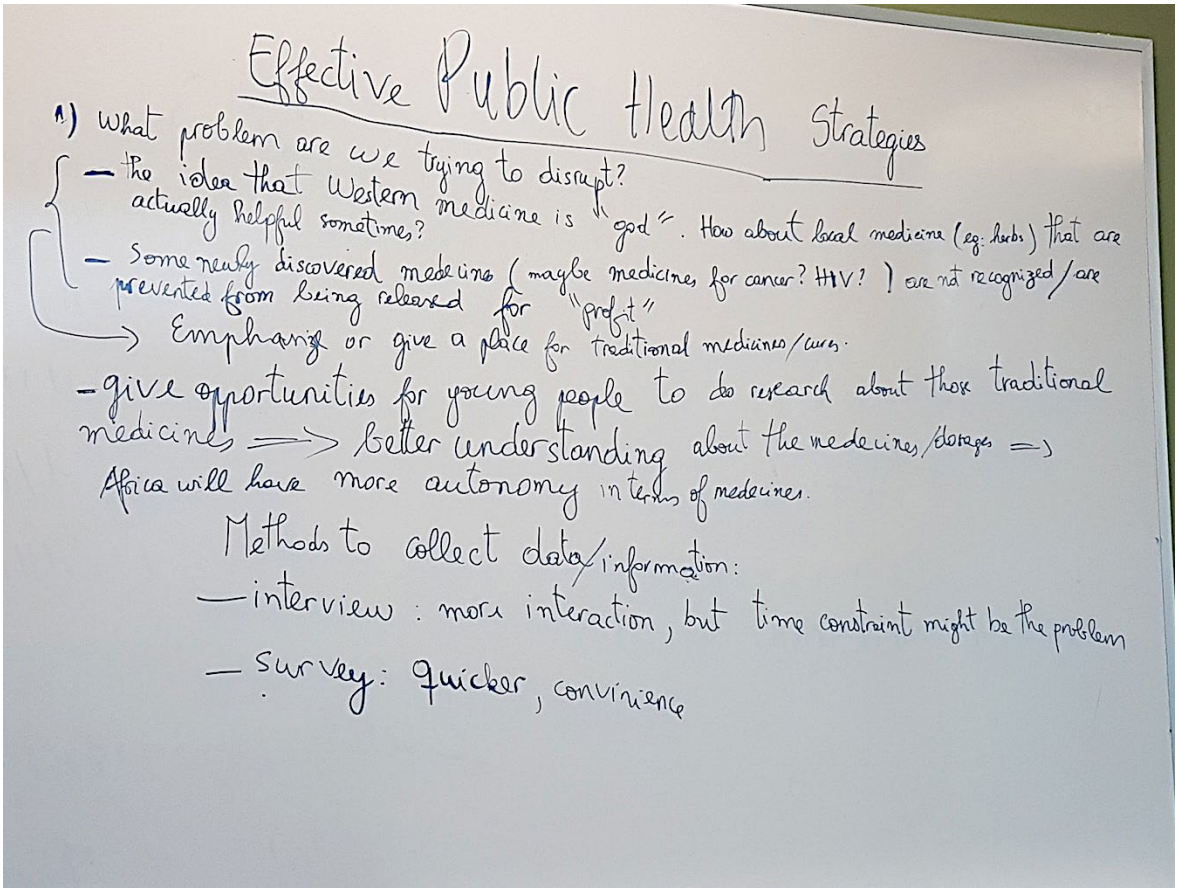
concern towards manufactured medicine because "the western side will continue to capitalize on people's health and what better place than Africa." This comment reminded me of the many ills of capitalism that were documented in the *Dark Waters* film mentioned earlier.

At the end of a lengthy conversation, the group decided on a specific social issue: disrupting the notion that manufactured (western) medicine should be the standard. We decided that the next step would be to understand African youth's experiences with both traditional and manufactured medicine. We took a similar approach as Turner and colleagues (2009) whose work in CME was also situated outside of a formal classroom; however, unlike their study in an after-school math program, my study did not have an implicit goal on learning new mathematics. Instead, I was interested in seeing if and how they drew on their previous mathematical learning in this investigation. related to my underlying goal in this work, which was to understand if and how mathematics explorations show up in social issue explorations, even when mathematics was not centered.

Process of Studying this Social Issue

We considered multiple possible methods of studying this issue. Sanyu suggested we interview youth, while Manyoni suggested focus groups because she valued the format of our current FAM sessions where we could build on each other's ideas. We discussed the pros and cons of both methods and Mendrika chimed in that a survey would allow us to conduct a statistical analysis. Njo chimed in that perhaps we can collect both qualitative and quantitative data to help us get a fuller picture of youth's experiences with both types of medicine. Because of time constraints, however, we settled on survey as our method while ensuring that the survey was a mix of open-ended and multiple-choice questions. Figure 16 shows the summary of our discussion prior to creating the survey.

Figure 16. Summary of discussion around social issue investigation



Drawing on our commitment to Sankofa, Njo suggested that we speak to an elder (e.g. a parent or grandparent) in our families, all of whom live in different African countries to inform the types of questions we might include on the survey. The results of our discussions with elders revealed three key points: elders understood the value of traditional medicine, elders veered away from traditional medicine because of a lack of precise dosages, elders' introduction to religion contradicted their beliefs in traditional medicine.

Regarding the latter finding, Soro shared how his grandfather instinctively knew what plants to pick out in the forest but that "instinct" was challenged, by those who had adapted organized religion like Christianity, as juju (voodoo) (Boutte, Johnson, & Muki, 2019). This was

helpful information for us as we set out to consider the questions to include on the survey geared towards youth.

Creating the Survey

None of the youth had experience using Qualtrics and since I had recently learned how to use it, albeit, at a basic level, I helped with inputting the questions the youth put forth. I was intentional in not taking the lead as the "academic researcher" in the space but helped clarify questions they posed to ensure the survey would be easily understood to our target population of African youth. We first included demographic questions including age and country of origin, then we asked how African youth define traditional and manufactured medicine, their experiences with each, and then shifted to questions about youth's description of manufactured vs traditional medicine and their experiences with both. Lastly, we asked questions that were future-facing such as which type of medicine youth were likely to consider and which they would pass to their children (see Figures 17 and 18 and Appendix D for the full list of questions).

Figure 17. Survey question about medicine preference

Figure 18. Survey question about preference for medicine to future offspring

After I typed in the survey items, each member of the group practiced taking the survey to ensure that there were no glaring issues in terms of clarity. We all then set out to share the survey with youth in our networks. I note here that, because time was quickly becoming a scarce commodity, we were not able to spend a lot of time troubleshooting the survey. With that in mind, given that we did not intend to publish the results of this survey but instead used this for our own inquiry, I was not too concerned about the survey being in line with survey research methods. In total, we received 17 responses. We were disappointed that we received a small number of responses over a two-week period, but we worked with the data nonetheless.

Analyzing the Data

I will not focus on explicating the details of the data received but how the group attempted to analyze the data collected. Initial data analysis took place at the April 3rd FAM session via video conferencing (I was away at a conference in Toronto, Canada) while the more in-depth process was on April 10th in person. Everyone participated as we read through the data and began making inferences through our analysis. Everyone had access to the survey as I had learned that there could be multiple administrators on a Qualtrics survey. This was particularly

useful because it meant we could each play around with the data using the tools embedded within Qualtrics itself.

Soro urged that we distribute the data into two piles. He advised that we analyze the multiple-choice questions using statistics while creating word clouds for the open response questions. His reasoning was "because when people define what is called traditional like if there's a word that keeps on coming back, it's like, the biggest word." Manyoni took the lead on displaying the multiple-choice questions using bar graphs while Sanyu and I searched for an appropriate word cloud to meet our needs. Soon we realized that the way we set up some questions on Qualtrics resulted in a misinterpretation of some of the items and so we tried to make sense of the responses. The following conversation stood out to me particularly as I was largely absent from it. It also showed how the group used mathematics as they tried to make sense of Qualtrics representation of our data.

Sanyu: Well in general, like over 50% are most likely to consider manufactured medicine. Is it just like 50 or the percentage might be even higher? I just don't remember [see Figure 17]

Soro: I think it is here. Like nine people said it depends, five people say, manufactured

Sanyu: Which question?

Soro: It's like, at a bottom of 15 question 15. Click on it you will see. I think the "why" is just people who answered [see Figure 17]

Molade: So yeah, it's just the same

Sanyu: Yeah, like so five say they will consider manufactured and like one say purely traditional

Manyoni: And we had 17 responses

Sanyu: What scale is this?

Soro: It's the number of people. Like one is one person said it, nine is like nine people but remember there's one person who didn't answer all the question but his data he didn't do it. So it's like, if you add this like 16 people right now, 15 so two people if someone doesn't answer it won't show up. Does that make sense what I'm saying?

Manyoni: Nope

Njo: She's trying to estimate the percentage of yeah

Sanyu: So, does this mean, which one are you looking at? This graph. Yeah. Yeah. So how many people?

Soro: Five people. It's not a total it's like, how do I explain it. So, like we have nine people, we have like nine because the highest is nine because nine people respond to one question but now you have like five people respond to this one, question to like manufacture. What are you trying to understand?

Sanyu: What's the total?

Soro: The total right now if you add all of them is like

Manyoni: 21

Soro: But what is confusing with that percentage is that the why, they are giving, why is not an option

Manyoni: Ohhhh

Soro: "Why" is like people typing in so they are counting the why as people, so some people also wrote it depends so that's why I'm not counting that why and we have only 17 people. [see Figure 17]

Manyoni: I think the way it was done is that it's considering "why" like as an option and not an expansion of one option, so you don't have like, you couldn't just pick why on its own but because people pick like traditional and why, it messes it up.

Soro: But I think when you just take into account traditional and manufactured, you take traditional, manufactured and it depend, you have nine plus five plus one which is 15.

Manyoni: Actually, I don't know maths

Njo: This is stats

The conversation here reveals how even though the focus of this research was not to learn new mathematics, youth were able to draw on their prior backgrounds in persevering and making sense of the numbers presented. Afterwards, Soro explained to Manyoni that the "why" we had listed across multiple questions was a separate choice [see Figure 17], thus, it was skewing the data. As both of them looked from the same computer screen, Manyoni had a revelatory moment when she uttered "ohhhh" to signify the accurate interpretation we needed to make about the data. She recognized the mistake we made with the representation of *why* because it was intended to be matched with each choice. For example, in Figure 17, if a youth indicated that they preferred traditional medicine, we hoped that they would give an explanation of why that would be their choice. Despite Manyoni's "ah-ha" moment, she quickly announced the commonly accepted phrase in society "I don't know math." Thus, even though we were working on interpreting a mathematical representation of the data, Manyoni did not connect this new mathematical understanding with her *knowing* mathematics but was quick to return to her narrative of her mathematical abilities. Moreover, a common theme throughout our FAM sessions was the youth's separation of mathematics and statistics. This is concerning given that the broad literature on mathematics for social justice has typically focused on mathematical applications using statistics (e.g. Gutstein, 2007; Raygoza, 2016), yet, the youth did not see statistics being the same as mathematics.

Recall that Soro was the singular male in our collective. I noticed a similarity across this data analysis session and the Monopoly game playing session. On both days, he took the lead in assisting the group make sense of the rules of Monopoly and in this case, on the numbers in the

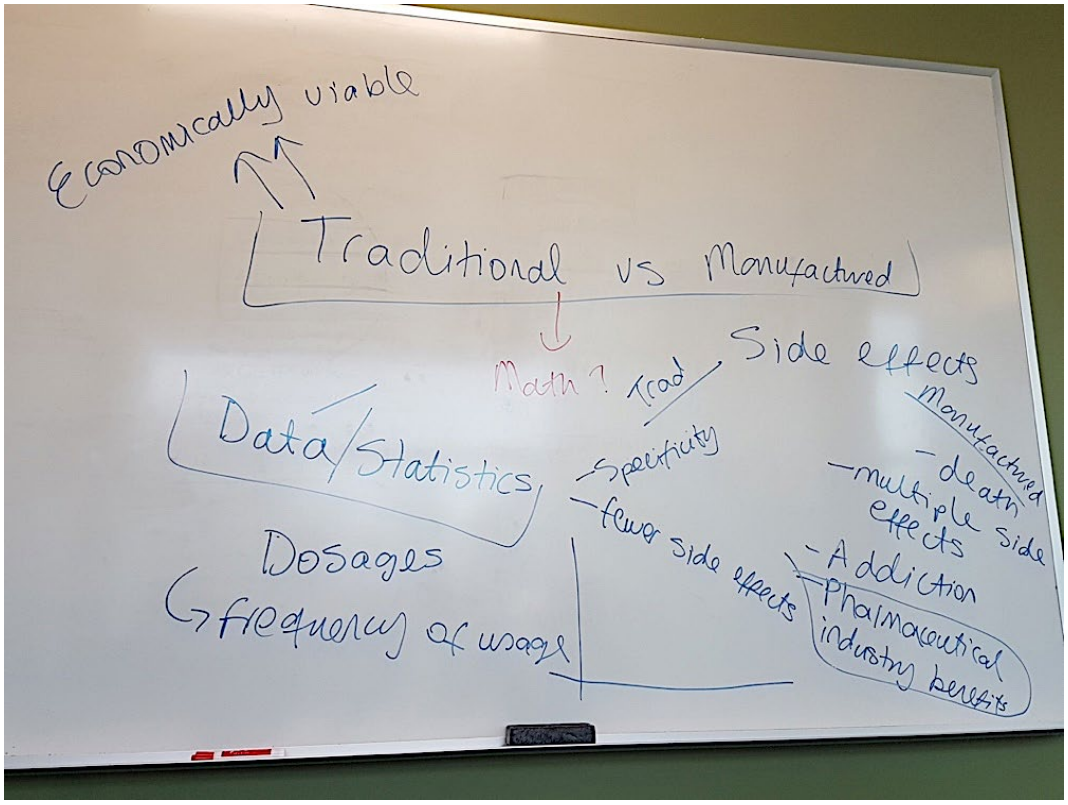
data to allow us to capture accurate findings. I wondered about the prior experiences the young women in the group had in their mathematics and broader STEM courses as gendered spaces and how Soro's leading might have continued to shape and reflect those experiences. In any investigation of social issues, there has to be a constant focus on decentering power structures at all levels – in this case, potential gendered power dynamics. This is necessary in out-of-school contexts like this and also in school contexts.

Math as A [Possible] Tool for Disruption

At the end of our exploration, the group recognized that the salient reason the 17 youth who responded to the survey might have shifted from a reliance on traditional medicines to manufactured medicines was because of the precision of dosages in manufactured medicine. This was similar to what we found when we spoke to elders in our lives. Dosages are a numerical measurement and it appears there is an inherent trust in precise measurement than in the feeling, intuition, or the "just knowing" that is a part of African Indigenous ways of knowing. Nevertheless, I wondered how we could utilize mathematics in the specific practice of showing the value of traditional medicines. Even though this did not organically arise, I asked the group if we could have a discussion around this idea. As we brainstormed, I documented the ideas on the board (see Figure 19).

Manyoni considered how many side effects are often associated with manufactured medicines. She pondered whether statistical data could be collected to show the side effects of using a manufactured medicine and traditional medicine for the same ailment. Soro added that mathematics can also show that traditional medicines are more economically viable than manufacture medicines given the variety of medicinal plants that are plentiful.

Figure 19. Collective discussion around benefits of traditional medicine



While I was in South Africa over the summer, I visited the internationally renowned Kirstenbosch gardens and documented just how many plants have been shown to treat ailments. See Appendix C for some examples from the pictures I captured, which I shared with co-researchers.

Soro further added that the risk of addiction is much lower in traditional medicine when compared to manufactured medicine. He shared that the pharmaceutical industry is notorious for making medicines that are addictive without sharing this information with the public. Lastly, Njo returned to the various ways of knowing mathematics we had discussed in prior sessions. To her, traditional doctors are simply using their own version of mathematics in their work and a method of disruption would be to elevate their own type of mathematics as well as the dominant mathematics. She shared,

> So, but there is nothing like *my math* in that like they [traditional doctors] will not tell me it's this concentration that will cause that to you, but they will tell you if you take more than two spoons of this, it can cause this to you. So that is their own [traditional doctors] maths. So like the difference in the math is what I'm looking at like how do we put that in today's discussion. I think that is something that we can try to disrupt like they [traditional doctors] have their own maths and pharmaceuticals have their own math but are these math different? Like they are all looking for the same thing so that you who is taking the medicine knows that is the correct amount for everybody. I think they all have the same ultimate goal but me and every other person right now wants the calibrated mathematics like the figured things, the units and everything.

Similar to the exploration around the mathematics embedded in our communities, Njo brought back the notion of different types of mathematics involved in manufactured medicine and traditional medicine. For Njo, elders who use traditional medicine informally tell their customers the appropriate amount to take as they have also learned what "dosage" to recommend. This measurement, however, is not the "calibrated mathematics" used in manufactured medicine that many youths are accustomed to. Njo posited the notion of "their math" and "our math." "Their math" being African Indigenous ways of knowing while "our math" is the dominant mathematics we learn in formal school spaces. Njo drew on African Indigenous knowledge practices that do not rely solely on naming and numbering. She later shared that the heavy reliance of naming and numbering is a western concept. More generally, this separation of formal (*our* math) and informal knowledge (*their* math) is an important dichotomy to attend to in decolonizing work.

As we continued to explore the role of mathematics as a tool for disruption particularly in school mathematics, the youth could not conceive applications of pure mathematics to social issues but felt that statistical applications would be the most compelling option. Soro shared the following,

> And I feel like data is like the most effective way. If you want to disrupt it just showing data, like how much financially money wise, how much we're spending on something

> compared to like, I don't know, because you don't have to speak, you just put data in front of people, they see the graph. Oh, this is higher, it's more money here.

Soro expressed a sentiment that [quantitative] data is enough to show that traditional medicines are more financially cost-efficient than manufactured medicines. In fact, he felt that "you don't have to speak" because numbers are essentially obvious, true, neutral. Research has shown how statistical data can be manipulated to tell a particular narrative (Tunstall, 2018). In some regard, Soro's statement supports the reason youth rely on manufactured medicine over traditional because dosages "speak" for themselves. Throughout data generation, I wondered about the role CME can play not just in pushing the notion that mathematics can and should be used to foster social justice but how CME can also challenge the role of mathematics, specifically data, in exacerbating social injustice (Rubel, Hall-Wieckert, & Lim, 2016).

Limitations of Math as A Tool for Disruption

Though the youth found ways mathematics could be harnessed as a tool for disruption, there was concern that mathematics has its limitations because there are African Indigenous practices that cannot be quantified. For example, Mendrika talked about a practice in the farming community in which she was raised. After sowing beans, the farmers take a few seconds to sit on the land before leaving. She shared that farmers believed that if they did not sit on the land, their harvest would not be plentiful. Our conversation veered into other traditional practices similar to Mendrika's that may not seem logical as to why they produce the intended results because elders "just know" even if no one knows the full reason behind this. Njo considered, "to enumerate it is the question. Like how do you put a number to that?" Similar to other sentiments expressed amongst the youth, connecting mathematics to social issues means quantifying it in some manner. These "just know" knowledges usually comes from traditions often passed down orally

that, though might not have scientific value, are still valid in African Indigenous knowledge systems (Abdi, 2002; Avoseh, 2000, 2011; Boutte, Johnson, & Muki, 2019; Greene, 2019).

Mendrika culminated our thoughts perfectly as she voiced, “Let’s say from outside you may feel like that doesn’t make sense at all but actually it does work and that is very interesting.” Njo further added that western religion impacted African traditional knowledges during colonization; a sentiment that has been acknowledged by scholars as well (Abdi, 2002; Ohuche, 1978; Mignolo, 2007; Wynter, 2003). Njo encapsulated this when she said “so religion came and met traditional knowledges and beliefs. People believe in God but they have traditional aspect that is not totally cleansed, is still there.” Njo is speaking about the tension elders face as their religious beliefs have nearly eradicated their traditional knowledges. Trevor Noah (2016) in his memoir, *Born A Crime*, put this accurately in his autobiographical book stating, “if you’re African and you pray to your ancestors, you’re a primitive” (p. 6). Returning to Mendrika’s comment above, it would be difficult to attempt to use mathematics to attempt to explain why some harvests are plentiful while others are not when a deeply held African Indigenous belief exists that the plenty is related to farmers taking a few seconds to sit on the land before leaving.

Interdisciplinary Exploration

Much of the conversation around traditional and manufactured medicine pointed to a need to show the medicinal components of traditional medicines to the public. As an aside, while I was in Lesotho over the summer, I learned about the practice of pregnant women and children eating clay/sand from the ground. This learning stayed with me because I recalled hearing Njo sharing the same practice in The Gambia with the group. She was so curious about this that she decided to collect a sample of the clay at a Gambian market in New York City during a visit so

she could study it. Using an electron microscope, she discovered that this sand had huge quantities of Iron in them. She went on to share,

> And so I went and searched about pregnant women and iron supply and figured out that pregnant women and children usually have like some deficiency in iron because children are growing they need a lot of iron for their muscles, bones to grow and all that. Pregnant women also have less iron supply. So like how in the world because these people are not educated. They don't know that this sand has this thing that my [their] body is lacking.

Njo remarked that even though the pregnant women are likely unaware of the Iron in the clay, it is the need for Iron that caused them to crave it. I bring this up because if students wanted to explore a social issue around the practice of rural women eating sand, this exploration would be incomplete using only a mathematical lens. Instead, they would need to understand this African Indigenous practice and perhaps draw on Njo's method of scientifically showing the benefits this sand has for pregnant women. For Njo and Soro, mathematics alone would be insufficient in highlighting the benefits of traditional medicines. Soro noted in the quote below that combining mathematics with other scientific disciplines would help make a case for people not to abandon traditional medicines:

> So if you have to teach it, just make it like take a plant and then look at it, what is inside it and how you can make it this way and what is the understanding behind it if you need to teach [it]. Because I guess it is going to be a modern school with all the technology and stuff so you can look at what are the composition [inside it]

There was a consensus in our discussion that pharmacy schools should also introduce traditional medicines alongside manufactured medicines to unearth the value of both. This indicates a need to include other disciplinary knowledges like Biology, Chemistry, and History alongside centering the voices of elders who can add their own African Indigenous ways of knowing in the context of medicine. This interdisciplinary focus on understanding this social

issue has implications for CME as well because it shows the limitation of approaching an exploration of social issues only from a mathematical perspective.

Envisioning CME in Sub-Saharan Africa

CME in the U.S. context has often made injustice the center of its exploration. For example, Gutstein's (2013, 2016) work with students in Chicago has highlighted the injustice in traffic stops between white people and people of color, and gentrification in Chicago. In this study, my analysis revealed that while youth recognized injustice in Africa (and broadly), there was a particular focus on highlighting the strengths of the continent. For instance, the use of elder knowledge, youth response to the surveys, along with their own experiences in the context of traditional versus manufactured medicine was intended to reveal the strengths of traditional medicine by showing its lack of side effects, economic viability, effectiveness, and ingenuity of elders. Essentially, youth were changing the focus of their inquiry by "accepting Africa as a legitimate epistemic centre from which we make sense of the world" (Ndlovu-Gatsheni, 2018, p. 39). Their approach to social issues was not to further document the problems on the continent but rather, leaning on the epistemic strength of Africa.

As we considered what CME might look like on the African continent, Sanyu felt that the first approach to take is to "empower it [mathematics] differently." For her, to empower mathematics meant to connect mathematics to practical applications within the community. Sanyu and Soro believed strongly that mathematics exists all around if you only look "hard enough" as was the instance of connecting mathematics to healthcare. Furthermore, Sanyu shared that if our goal is to have young people make a positive impact in their communities, mathematics needs to be owned by Africans and not from books that come from the west because "math is math." I was struck by Sanyu's statement that "math is math" because initially, it

appeared to diverge from Njo's conception of "their math" versus "our math;" however, she further asserted that her own grandfather used informal mathematical knowledge to quantify the different elements when he made traditional medicine. Additionally, the other examples shared pointed to the youth wanting to show that the informal way of doing mathematics was just as valid as school mathematics. For instance, Njo returning to the social issue we studied restated that, "I think there are measurements [in traditional medicine] it's just not what we know as measurement.

Njo insisted that if mathematics is to be introduced in ways that highlighted the mathematical knowledges embedded in traditional practices, it would be more accessible to young Africans. Analyzing the Kore musical instrument mentioned earlier, Njo wondered about the geometrical consideration of the calabash or the measurement of the strings to achieve the intended pitch. Recall that Njo struggled with mathematics and did not feel like she was connected to the subject. She insisted that, "if African things are used in teaching that math, it will be more easier … I think math is already part of us. It's just the teaching that makes us think that is different from what we know." Soro chimed in that though Africans are known for their oral traditions, perhaps it is time we documented our practices in written form this time to show the richness of our mathematics heritage. Thus, I posit that for these youth, CME is not about using mathematics to reveal a specific injustice, but more pressing would be to use mathematics in ways that connects to African Indigenous knowledges and practices.

In the final sub-section of this findings chapter, I engage with Sankofa once more by reflecting on the overall research process. I also share reflections on a conversation I had with co-researchers almost a year after the culmination of data generation. It was profound to hear

how the youth had continued to think about ways to elevate traditional medicines even while acknowledging their reliance and trust in manufactured medicines as well.

I Feel Like Looking Back Propelled Us Forward

I contemplated the necessity of this final section but ultimately recognized that it was important for me to reflect on the overall journey of this study before the discussion chapter. As I consider the role of decolonizing theory and methodology, I am grateful that the youth and I were able to unpack harm done in mathematics and beyond, recognize our shared love for the African continent, and consider how to highlight the strength of our continent with and without mathematics.

Across the findings in this chapter, I hope I drew you, the reader, in to experience and learn with me and the five youth with whom I partnered. Our commitment to learning together was crucial as it allowed new meanings and new understandings to emerge. The shift towards Indigenous ways of knowing was not planned but opened a new space of possibility that ultimately fostered the work. I strove to reject the "researcher" role and though it took some time, I was grateful for the various ways the youth took up the work as theirs. I was intentional in revisiting consent throughout the study because I recognized that a humanizing lens to research does not purport that consent is only given once. But all was not perfect. Leaving the scope of each FAM session largely open brought about many fears. I wondered if this dissertation would produce any findings worth discussing. I am grateful that not only do I have valuable findings, but that this space was life-giving for each of us. The findings revealed the importance and value of community, elder knowledge, and Indigenous ways of knowing, as well as the effect of colonization, and rewriting of narratives.

Almost a year after we started our work together, we met as a group to check in with one another. Njo shared with us that because of our research, she organized a clinic day in her community over the summer 2019 break. She further noted that she had asked the village leaders why they were now open to manufactured medicines and was surprised to hear their answer. The village leaders shared that due to climate change and the loss of trees, they no longer had access to the traditional herbs they were accustomed to. Furthermore, there was a loss of Indigenous knowledges around the types of traditional medicines for different ailments because of a lack of documentation. As we reflected on the reasons the youth we surveyed gave for relying on manufactured medicines, there was a sentiment that the idea of wanting a precise dosage was in itself "a western way" of thinking. It was powerful to see that the ideas we discussed still resonated long after our formal work together ended.

I am grateful that I was afforded the opportunity to co-lead a study abroad to South Africa soon after the culmination of data generation. I was struck by how much overlap I noticed between the ideas shared in FAM sessions and what I saw or learned while in South Africa. Even though I had lived in South Africa for five years, I was not as attentive to Indigenous ways of knowing as I am now. I remember sitting in an elementary mathematics classroom in the Eastern Cape province and seeing how stilted the classroom environment was. The students worked alone, the boys mostly answered questions posed by the teacher and the classroom seemed particularly joyless. I asked the teacher afterwards if her students worked together and she shared that she preferred they work alone to properly evaluate their performance. This classroom environment was not an isolated event and yet I think about the power of employing Ubuntu in these mathematics classrooms. How powerful would it be if the students were allowed to share and grow their mathematics understanding with their classmates? Moreover, I thought about the

incredibly loving and supportive space I was privileged to be a part of for 12 weeks in this co-learning experience. I wondered how powerful the mathematics learning of these young students would be if the beautiful necklaces their Gogos (grandmother in Zulu) made could be brought into their classroom. I thought about the community learning under the Baobab tree. I thought about Ngugi wa Thiong'o and how the education I observed was not emotionally felt. Though at first dejected, I was grateful for the learning I gained in the process of this dissertation and how I might support teachers and students moving forward.

At our last official FAM session, Mendrika thanked everyone for our "wonderful group" while Sanyu shared that this work showed her a different way research could be done. Sanyu stated, "I feel like looking back, propelled us forward…everything we have done so far, has come from looking back." While I had hoped to involve each youth in the overall analysis, their busy schedule did not allow this to happen, but I hope I have done our work justice. I am grateful to Manyoni, Mendrika, Njo, Sanyu, and Soro for entrusting me and each other throughout our time together. In the final chapter that follows, I synthesize the findings chapter by directly linking my findings to my research questions. Then I discuss the implications of this study to theory, methodology, and practice along with my concluding thoughts.

Chapter 5: Lasting Legacy of the Baobab Tree

"A tree has roots in the soil yet reaches to the sky. It tells us that in order to aspire we need to be grounded and that no matter how high we go it is from our roots that we draw sustenance. It is a reminder to all of us who have had success that we cannot forget where we came from. It signifies that no matter how powerful we become in government or how many awards we receive, our power and strength and our ability to reach our goals depend on the people, those whose work remain unseen, who are the soil out of which we grow, the shoulders on which we stand." (*Maathai, 2007, p. 293)*

I begin this concluding chapter with the words of Wangari Maathai who I reference earlier in the third chapter of this dissertation. Her words are apt for this chapter as she reminds me that I did not do this work alone. As a Baobab tree lives for thousands of years, I similarly hope that this dissertation opens possibilities for others to partner with me in this work. As a tree needs the right conditions to thrive, I realized that I also needed appropriate conditions to write this dissertation productively. Therefore, I took an act of disruption by pausing to write out my feelings, particularly because I wrote the entirety of this chapter during a global pandemic[15]. Then, I revisit the roots and seeds of the Baobab tree in an effort to show how the fruits of the Baobab tree grow, connect to, and enhance decolonizing methodologies and critical mathematics education. Additionally, I discuss the implications of this study for decolonial theory, methodologies, and practice. I end by discussing my wonderings around this dissertation along with considerations for future research.

Dissertating in the Era of COVID-19

It dawned on me yesterday (March 30th, 2020) that this was the first chapter written entirely during the COVID-19 pandemic. As I battled writing this final chapter, I realized that my struggle was not stemming from the making the scholarly connections required of me. Instead, I

[15] The COVID-19 global pandemic began in China around the fall of 2019 and spread to many countries afterwards causing a global standstill in typical daily practices as we tried to practice social distancing. Locally, Michigan State University ended in-person classes on March 11th shifting to an on-line format. This meant that I defended this dissertation in my dining room as my committed members and friends watched me via Zoom.

had to finally admit that writing for the last three weeks while so many are facing immense devastation from this pandemic feels wrong. I am going to listen once more to Patel (2016) by taking time out to pause. It is necessary for me to write through these feelings because disruption has been a core part of this dissertation.

Yesterday, as I wrapped up my writing in the evening and shared my progress with a friend, tears began flowing. I cried because I wondered what the point of this dissertation was in the middle of an unprecedented world crisis. I cried because I am worried about my friends and family across the globe. I cried because graduate school has been tough and the thought of "defending" this dissertation alone in my dining room feels devastating. I cried because I would not get to hug my family when this is all over. I cried because my doctoral journey will end in an anticlimactic manner. I reached out to co-researchers to check in as I have done since the day we met, and they are also rightfully worried and anxious about their own families. As these thoughts circled my mind, my colleague and friend, Vivek Vellanki wrote the following in an email as he also was thinking about the conundrum of writing a dissertation in such uncertain times,

> My words and my work seem futile in this moment, they feel small and inconsequential when measured against all the pain, suffering, and upheaval we are experiencing, individually and collectively. And all the courage, compassion, and conviction we are surrounded by. I am not trying to use this moment as an excuse to shy away from writing…But this moment is making me question the nature of the work and writing I do as a part of the academy. Questions that have lingered with me throughout the course of my dissertation but that are exacerbated by this current moment. (personal communication, April 4, 2020)

Vivek's words perfectly captured my feelings around academia in a time of crisis. As an educator, I worry about the impact of the pandemic on students. I worry about the impact of the pandemic on those who rely on school for meals or some normalcy because home is not safe. I worry about how inequities would worsen in this season. For example, my friend told me her children's school district provided personal computers to every child within their district to enable them to continue schoolwork from home. Many others do not have such luxury. For instance, my nieces in Nigeria do not own personal computers and their teachers, like many others in the country, do not have frequent and uninterrupted access to the internet.

So, when I saw materials floating on Facebook about how we can connect this pandemic to CME, something did not sit right within me. I am still working through my feelings (at this time) about why I feel uncomfortable, but I wonder if learning mathematics using the pandemic as a context is helpful for anyone. As I laid in bed last night, I wondered "Can mathematics education save us?" borrowing from Bullock's (2017) paper. Larnell, Bullock, and Jett (2016) draw on critical race theory to interrogate the goals of teaching and learning mathematics for social justice (or CME as I note in this dissertation). Their analysis revealed the shortcomings of CME as they assert that analyzing social justice tasks without attending to the "intersectional nature of justice" (p. 27) is necessarily incomplete. This lack of complexity often embroiled in CME tasks perhaps helps unravel the discomfort I felt. CME for Larnell, Bullock, and Jett (2016), should be "more than just a collection of curricular tasks" (p. 27). CME educators need to step outside of mathematics to consider what really matters at this time: that students learn mathematics using the current context or that we rally to make sure these same students are fed, have shelter, and are physically, mentally, and emotionally well.

In a related note, I also came across a journal seeking submission around mathematics education in this time of crisis. Publication is *the* currency within academia, thus those whose articles or essays get published in this journal will amass more currency to advance in their careers. But I wonder who these people are? Are the editors taking into account those with younger children who have to be cared for in this time? Those who might actually contract this virus? Those who are filled with worry about older parents or friends and family with underlying conditions causing them to be susceptible to this virus? Worse, this journal still requires that these articles or essays go through the peer-review process. Once more, I ask, "Can mathematics education save us?"

It is difficult to decide how to end this line of thought but perhaps I do not have to because I am not sure how the pandemic ends.

Synthesis of Findings

I was motivated to engage in this research to co-explore with Sub-Saharan African youth to understand if and how we use mathematics in understanding, challenging, and disrupting social issues. I presented my findings across six sections in the findings chapter by showing the interconnectedness of themes related to community, elder knowledge, Indigenous knowledge, the role of women, the effect of colonization, and rewriting of histories. I will now provide a synthesis of my findings to the three research questions I set out to answer in this research.

What Knowledges Do Sub-Saharan African Youth Draw Upon in Their Investigation of Social Issues? How Might These Knowledges Advance Our Understanding of CME?

My findings suggest that Sub-Saharan African youth drew on knowledges of sociohistorical and sociopolitical understanding of their communities and Sub-Saharan Africa largely. Additionally, youth drew on elder and embodied and/or intuitive knowledges in their

investigation. Youth also drew on their own knowledge of pre-colonial African education in interrogating the ways western ways of knowing have marginalized and rendered invisible African Indigenous ways of knowing. This was evident from the "what Africa means to you" narratives up until the investigation related to traditional and manufactured medicines. Connected to African Indigenous ways of knowing, youth also drew on elder knowledge in their investigation. There was a reverence for the knowledges of those who came before us in the African context. For instance, when Njo assigned the group an assignment to speak to elders seeking information on their own experiences with manufactured and traditional medicines. Youth also pulled on what I call "I just know" or embodied knowledges (Boutte, Johnson, & Muki, 2019). That is, they drew on their own experiences, convictions, and intuitions as they explored social issues. Further, they spoke of elders' "just know" knowledges, as well, in valuing knowledges that might not have resulted from formal education in a western context.

So how might these knowledges advance our understanding of CME? Recognizing that I draw from the strand of CME that seeks to redress social justice using mathematics, the findings from this research show the possibilities for CME in an African context. Thus, while Gutstein's (2007) framework connects the critical, community, and classical knowledges, towards a *goal* of critical consciousness and later on for racial justice within a U.S. context (Gutstein, 2016), my findings signify that a *goal* of CME in a Sub-Saharan African context is to *render visible that which has been made invisible*. In other words, youth are not simply *reading* and *writing* an already existing world but are invested in *re-reading* and *re-writing* their African world by *shifting the center*. Drawing on Ndlovu-Gatsheni (2015, 2018), youth were *shifting the center* from a western perspective to unabashedly centering an African worldview. Colonization distorted histories and I noticed youth's commitment to returning to the root. These youth re-

wrote these false or invisiblized narratives using African Indigenous knowledges, focused on strengths instead of limitations.

Dei's (1994) early work helps me contextualize this focus as he identified that centering African Indigenous knowledges is "a weapon of liberation" (p. 17) to counter western ideologies in schooling. Furthermore, he asserted that it is not enough for an African-centered education to be emancipatory or liberatory as is the case with critical pedagogy from a Freirean perspective. Instead, African Indigenous knowledges offer "a language of possibility through which to deconstruct and reclaim, not only new forms of knowledge" (Dei, 1994, p. 19) but also to reconstruct, challenge, and contest identities, histories, voices, and place.

Moreover, the findings point to the necessity of expanding our understanding of social justice as not only considering issues of justice at present, but also cognitive justice that calls to the past. Cognitive justice works at redressing epistemicides (loss of indigenous knowledges) caused by colonization and push us towards epistemic freedom (Ndlovu-Gatsheni, 2015, 2018). That is, "democratising 'knowledge' from its current rendition in the singular into its plural known as 'knowledges'" (Ndlovu-Gatsheni, 2018, p. 18). In other words, decolonial theory helps to consider changing the center by not starting our focus on the issues of injustice but starting from a recognition of the knowledges that are often marginalized by school mathematics. I wonder what could be gained if, within CME, we create space for young people to find strengths within their own communities before interrogating important social issues.

When and How Do Sub-Saharan African Youth Draw on Mathematics, Broadly, To Understand and To Disrupt Social Issues? How Do They View the Role of Mathematics in Disrupting These Social Issues?

In my reflection I realized that this research question is at odds with the theory, frameworks and methodologies that I employed in this research. This question centers mathematics squarely even though I tried to decenter it during much of the data generation process. Nevertheless, stemming from Sanyu's comment about the connection between a right-angle and a white man, co-researchers and I engaged in an activity of identifying the mathematical practices in various African artifacts. In this activity, there was a focus not simply on discussing the formal mathematics embedded within these practices but showing how elder knowledge was sophisticated and valuable. More pointedly, Sub-Saharan African youth drew on mathematics, statistics specifically, when collecting and analyzing the data collected in the PAR project. There was a consistent rhetoric that quantitative data was widely respected, neutral, and accepted, therefore necessary in making an argument to redress a social issue.

Considering the role of mathematics to disrupt social issues, my findings suggest that the youth's focus was in bringing African Indigenous knowledges, elder knowledge, and "I just know" knowledge into mathematics learning spaces. As Njo and Sanyu asserted, there are different forms of "mathematics" at play namely "my math" and "their math." Njo discussed the elevation of formal [school] mathematics (my math) over Indigenous [African] ways of knowing mathematics (their math) that valued intuition and decentered an overreliance of numbering. Despite this recognition, when Manyoni was faced with the challenge of interpreting the statistical data collected, she quickly resorted to the often-stated phrase "I don't know maths." This implies that the belief that there are individuals who are "math doers" and others not is so

seeped into our consciousness such that more unlearning is needed before one can really believe that “I already knew maths in my own way.”

What Affordances Does an African Epistemological Grounding Have as Youth and I Engage in The Research Process?

As I wrote throughout my findings chapter, the influence of African epistemological grounding was invaluable. Engaging with Sankofa, Ubuntu, and FAM within the framing of decolonial theory opened the space for co-learning, reflecting on previous experiences before moving forward, and finding the joy within this work. The sharing of identity narratives at the start was a defining moment as it was in that activity that we began recognizing our overlapping commitments to the African continent. Instead of starting from problems and issues that exist in our different African countries, we all embodied Ubuntu by affirming the importance of community, creativity, elders, women, and pan-Africanism. These were powerful moments as we were able to cultivate a space and make shifts towards epistemic freedom. We co-learned, reflected on prior experiences and prehistoric African education, became consciously aware of multiple ways of knowing, valued these multiple ways of knowing, disrupted power within colonial discourses, and exhibited joy in the process. Youth showed how, through looking at cultural artifacts and reflecting on prior experiences, we were able to value Indigenous [mathematics] knowledge. Moreover, there was an assertion that if young children are given the opportunity to see the multiplicity of knowledges within their communities, perhaps they will enter formal mathematics spaces with more confidence and belief in their abilities.

Taken together, drawing on decolonial theory, Ubuntu, Sankofa, and FAM allowed myself and the youth co-researchers to engage in ways that led us towards epistemic freedom. We first began with identity-related discussions and explorations as evident in the first two

subsections of the findings chapter. In the process, we also disrupted colonial discourses that led to deep insights into multiple ways of knowing. These included African Indigenous knowledges, elder knowledge, and embodied knowledges typically absent in western education. This then led to valuing these multiple ways of knowing even in the context of mathematics as was evident in the social issue exploration around traditional and manufactured medicines. Lastly, this shifted us towards epistemic freedom (or cognitive justice) that I will capture using Njo's words "so that's just a realization I'm getting because I never liked maths in school but I never knew that I already knew maths in my own way!"

Teacher Don't Teach Me Nonsense

As I consider the implications and future considerations of this research, I am reminded of the title of Fela's (1986) song *Teacher Don't Teach Me Nonsense* that struck me and has stuck with me since the day I heard it. To avoid *teaching nonsense*, I will offer implications of this research but remind the reader that there are multiple stories that could be taken from this study. Additionally, I will focus these implications within a Sub-Saharan African context. This is not to say that others will not have takeaways from my study but as I expressed in my opening chapter, this dissertation is a love-letter to my African continent.

Learning from Decolonial Theory

Patel (2016) argued, "many theories can be used to explain experiences and data, but they do not do so equally" (p. 60). I conducted this research rooted in African decolonial theory and African frameworks to consider how CME might be envisioned with Sub-Saharan African youth. Thus, taking on a decolonial lens is crucial and necessary in challenging what mathematics knowledge is privileged. Decolonial theory pushed me to shift my lens away from a western gaze

and instead to center African ways of doing, knowing, and being. In doing so, I noticed a gap in the extant CME literature that I address in this study.

CME scholars have often tackled social (in)justice by using the dominant mathematics to illuminate unjust practices or policies. Although this is necessary work, decolonial theory illuminated another important aspect of social justice particularly for the colonized Other. Ndlovu-Gatsheni (2018) posited that an essential aspect of decolonial theory, particularly for Africans, is in redressing epistemicides (loss of Indigenous knowledges). In some ways, this redressing of epistemicides pushes on the importance of taking an intersectional lens within CME. Reiterating Larnell, Bullock, and Jett's (2016) argument, CME cannot fully address its social justice goals without attending to the "intersectional nature of justice" (p. 27). Additionally, Ndlovu-Gatsheni asserted that this reclaiming of African Indigenous knowledges and de-westernization of knowledges addresses cognitive justice, a component of social justice.

In this research, it was imperative co-researchers and I were able to widen our lenses beyond the way our communities *are* but rather, to also interrogate the past and let this learning inform our future. As an emerging decolonial theorist, I was challenged to push beyond the boundaries of knowledges that I had considered in CME thus far, which I discuss next. I am hopeful that African scholars would draw on and build from decolonial theory to seek possibilities for mathematics education and education broadly; the type of education that is worthy of our students.

Learning from Ubuntu, Sankofa, and FAM

Building from decolonial theory, it was essential that I learned with and from three African frameworks throughout this dissertation. Ubuntu was critical in allowing us to learn, build, and share together in community. This building of community began almost a year prior to

the start of this research and has continued long after the official end of this research. Sankofa also pushed co-researchers and me to continually reflect on prior experiences and learning and to bring them in conversation with the social issues we discussed. Lastly, FAM helped me center co-learning in the research space. As I have described earlier, I continually sought to remove the "researcher" role and did my best to ensure that we learned with and from one another. FAM also helped us be clear on what we were disrupting implicitly and explicitly. Lastly, FAM allowed me to see moments of joy that emerged in this research.

I challenge CME scholars to expand the methodologies they draw on in research contexts because different methodologies unearth different and novel insights into advancing this work. Decolonizing methodologies was invaluable in helping me consider what it means to embed co-learning/community, disruption, and joy, along with the praxis of looking back before looking forward before, during, and after the research process. Decolonization also supports healing, transformation, and self-determination (Chilisa, 2011; Smith, 1999) that allow CME to shift from what might be seen as a damage-centered frame (starting from injustices) towards a desire-based framework (Tuck & Yang, 2014). Tuck and Yang caution us to consider what it means to consistently retell narratives of pain and to consider if wins [e.g. critical consciousness] are "worth the long-term costs of thinking of ourselves as damaged" (Tuck, 2009, p. 415). Tuck (2009) challenges us to consider a desire-based framework that "accounts for the loss and despair, but also the hope, the visions, the wisdom of lived lives and communities" (p. 417). Starting CME inquiry from the injustices in society might be considered damage-centered but a decolonizing stance pushes us to reconsider the starting point of our inquiries. Kokka's (2018) study is notable in that she acknowledged the possibility of re-traumatizing students when discussing social issues.

I do not intend to assume that these frameworks can or should be translated outside of research with African populations, but I believe much can be learned from these frameworks. For instance, I noted in my literature review that much of CME work has been done within formal schooling spaces (Brantlinger, 2007; Brelias, 2015; Gregson, 2013; Gutstein, 2003, 2006, 2016), but what else might we learn when we go out of this space? Additionally, how can we better center relationality in CME research and praxis? That is, how can we ensure that we draw on participatory methodologies within CME to ensure that we are emphasizing the need for *teacher* and *student* or *researcher* and *participant* to grow in their own understanding of social justice (Gutstein, 2016). More often than not, teachers or teacher-researchers decide on the social issues they believe students should study in their mathematics classes. Even in cases where the teacher is a member of the community (e.g. Kokka, 2018), we ought to give students the chance to share issues they are interested in exploring and disrupting (Gutstein, 2016; Raygoza, 2016; Terry, 2009).

So how might an African decolonizing lens build on and expand CME for African youth? For this, I turn to Dei (1994) who remarks that African youth "need to be active generators of their own knowledge…[through] a language of possibility" (p. 19). This language of possibility includes a search of "self-rule, self-regeneration, self-understanding, self-definition, self-knowing, and self-articulation of African issues after centuries of domination and silencing" (Ndlovu-Gatsheni, 2018, p. 26). Essentially, it is important that African youth be given the space and opportunity to discuss social issues from their own experiences.

Bridging CME, Ethnomathematics, and Indigenous Ways of Knowing

When Sanyu stated that "whenever you see a right-angle, it means a white man has been there," it changed the course of our research space. I had not intended on bridging CME,

ethnomathematics, or Indigenous ways of knowing in mathematics in this research because it has largely been separated within the body of research in three major mathematics education journals thus far (Dubbs, 2020). In this research, I make an argument for the bridging of these fields of research as my research revealed how the overlap of these ideas engendered what Ndlovu-Gatsheni (2018) called critical decolonial consciousness. Drawing on decolonial theory and frameworks, I argue that critical consciousness raising needs to embed decolonial notions of questioning the past, present, and future repercussions of colonization and settler colonialism (Tuck & Yang, 2014). Thus, within Gutstein's (2007) framework for CME, we need to expand the goal of CME beyond critical consciousness raising and racial justice to also dismantling settler colonialism in settler nation-states. In the Sub-Saharan African context, one cannot underestimate the damage and continued vestiges brought on by colonization. My research has shown that when youth see the embedded Indigenous [mathematics] knowledges within cultural practices or artifacts, they feel ownership of their school mathematics.

Wood (2000) noted that "mathematics has been part of all societies, a part of every profession as well as everyday life. Western mathematics became narrower with the insistence that only deductive mathematics from a set of axioms, following the Greek tradition, was *real* mathematics" (p. 2). Further, Joseph (1987) added that "mathematics is perceived as an exclusive product of white men and European civilisations" (p. 16). Thus, I am arguing that CME, ethnomathematics, and Indigenous ways of knowing together have much to offer when their goals are combined. Ethnomathematics, when conducted by members of communities and not through a western gaze, allows members of communities to consider the different knowledges that serve to add to Gutstein's (2007) framework. Beyond the community and critical knowledge, ethnomathematics can open up space to challenge the classical knowledge within

this framework. As Stathopoulou and Appelbaum (2016) note, “ethnomathematics has understood from its inception that mathematical knowledge is not historically - and culturally - embedded in Western mathematics” (p. 33). I am reminded of the boat example that Njo brought up in one of our FAM sessions. There, she, along with the rest of the group, contended that there was deep mathematics present in these activities even though these might have been seen as “common sense” knowledge. Mukhopadhyay (2013) also discussed how men in the Bay of Bengal made boats that are functional and durable over many years despite having no formal training. When Mukhopadhyay probed the men to inquire about their lack of reliance on scientific drawings, the men felt that they had enough practical knowledge that had been passed down from generations.

I bring this up to show that while some may categorize this as community knowledge, I opine that there are also aspects of informal classical knowledge present. Critical knowledge currently focuses on the dominant mathematics from within school contexts but there is an inherent assumption that this type of mathematics is the only type that is accepted. Yet, mathematics education scholars who have focused on Indigenous ways of knowing (Lipka et al. 2005; Meaney, Trinick, & Fairhall, 2013; Wagner & Borden, 2015) would insist that there are other ways of conceptualizing what counts as mathematics similar to the ways co-researchers did. As Wagner and Borden (2015) conveyed, “most people think math is what happens in school, in math class, but we can say there are other things that are math” (p. 116). Thus, I wonder what could be gained when we interrogate the mathematics within the critical knowledge and make room for other types of mathematics knowledge not solely located in the school mathematics curriculum. Moreover, my work further pushes collaborators (e.g. teachers, administrators, curriculum writers, mathematics teacher educators) to consider the place of

embodied and elder knowledges in mathematics curriculum. Meaney, Trinick, and Fairhall (2013) caution educators not to embed these knowledges in a "tokenistic manner" but instead in ways that support student's mathematics identities and learning.

Ultimately, viewing CME through the lens of decolonial theory would mean disrupting how CME aids the coloniality of being, knowledge, and power. I will return to and build on Gutstein's (2016) pronouncement by restating that "the purpose [of CME] is explicit—to prepare students to transform an unjust reality, *[including histories of colonization and settler colonialism]* with and without *[various forms of]* mathematics, as they see fit" (p. 488).

Returning to Sub-Saharan Education

This dissertation further speaks to the importance of decolonizing Sub-Saharan African education and how mathematics is implicated. Wane (2008) asked "How did colonial systems of education disrupt the spiritual and cultural beliefs and traditional ways of life of African peoples?" (p. 184). I began answering this important question in this study and will continue seeking out ways to reestablish African Indigenous knowledges in schools because like Dei (2012), my education taught me more about the colonialists' traditions than my own communities.

Wonderings and Considerations for Future Research

Although I acknowledge the many strengths of this study, it is important that I also consider the constraints I encountered in this study. I wondered other ways I could have engaged with co-researchers in building practices that could have further built community in our research space. For instance, starting or ending each FAM session with a proverb from an African country. Another question in this study came from the location of this study. While everyone in this space was African, we had all been in the United States for at least a year and a half which might have

influenced the lens we took in sharing our stories. An important future investigation would be to consider the ways a study like this would be strengthened if I had been directly located in an African country as I also would have been able to engage with community members and elders more directly. Lastly, I could have engaged co-researchers more directly in the tensions that might have arisen in naming mathematical practices, as we later discussed that the act of naming itself is a colonizing practice.

It is important that I acknowledge that taking a decolonizing and participatory approach in research comes with challenges. It is not comfortable to approach research in ways that are not structured, but I can attest that it is a risk that yields rewards. Additionally, though I attempted to veer away from western and traditional ways of conducting research, I still could not avoid drawing on language and labels that "legitimize one's scholarship" (Koro-Ljunbgerg, 2015, p. 12). Like Salem (2019), I recognize that,

> Such labels and language are part and parcel of the colonizer's language and discourses. Attending to the requirements for dissertation writing, using headings and titles to describe my participants, and adhering to some methodological conventions that are accepted as a reflection of good research somehow invoked the colonizer's language and practice. Despite my efforts to (un)settle Western practices, the process was incomplete and fell short of perfection. (p. 157)

I will continue on this journey of unsettling colonial practices and continue seeking ways to interrogate naming practices that uphold western and colonizing research.

Considering areas of work my research opens, there is more work needed to examine what else decolonial theory and decolonization offers for CME. For example, examining how CME, ethnomathematics, and Indigenous ways of knowing merge together and what else their

combination might bring to bear. Furthermore, there are questions that I plan to explore from this study, such as: How can mathematics learning environments be designed in ways that ground African Indigenous knowledges as a starting point? How might decolonial methodologies support Sub-Saharan African immigrants' and refugees' mathematics identity development? How can African intergenerational experiences be foregrounded to improve mathematics learning? This study has now become the roots of my next set of explorations.

Conclusion

Ladson-Billing (2000) wrote, "my research is a part of my life and my life is a part of my research" (p. 268). I echo these profound words in the way I approach my research. In this study, I was intentional in centering the voices of Sub-Saharan African youth in the CME landscape. Similar to Wane (2009), I recognized "that colonial education has never been inclusive" (p. 161). Therefore, I knew taking a decolonizing approach was crucial in imagining critical mathematics education in an African context. I wanted to consider how CME could be envisioned in ways that would be liberatory for Sub-Saharan Africans. Further, I recognized that I was not doing this work simply for the sake of research. Instead, I harkened to Dei (2012) who stressed that the pursuit of a decolonial education is "not simply in affirmation and self-defence of our knowledges and experiences, but also to liberate ourselves, bodies and minds from Eurocentric mimicry" (p. 110).

As I return to the image of a Baobab tree (Figure 20), I am grateful for this symbol of community, creativity, pan-Africanism, and the fight to showcase the brilliance of Africans past, Africans present, and Africans in the future. This research offered much in the theory, methodologies, epistemologies, and the findings I shared reiterated the importance and value of African Indigenous knowledges. Because of the learning in our FAM sessions, we planned an

event to introduce a storytelling activity around “what Africa means to you” in our local community but unfortunately, the event was canceled due to the COVID-19 pandemic. Nevertheless, I have been inspired to create a storytelling podcast titled Baobab Tales where young Africans will tell their own stories.

Figure 20. Baobab tree

I will end with the words that Mama Graça Machel spoke at the keynote address during the African Leadership Academy’s decennial ceremony. She said, “Integrity makes you realize that you’ve never arrived. There is always more to do.”

APPENDICES

APPENDIX A: Research Participant Information and Consent Form

You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Study Title: Embodying Ubuntu and Invoking Sankofa: A Co-Exploration of Social Issues and Critical Mathematics Education with African Nonimmigrant Youth

1. PURPOSE OF RESEARCH

The purpose of this research study is to understand if and how you use mathematics in understanding social issues related to the African continent. This study is important to understand how youth see themselves as positive change agents in Africa. Furthermore, this study will inform the mathematics education community on approaches to social justice teaching in mathematics education.

2. WHAT YOU WILL DO

You are being asked to participate in multiple group sessions starting from November until March to investigate social issues related to the African continent. Because this study is taking a participatory approach, there will be collaboration involved at every stage. With that in mind, this study will have three phases. In the first phase, I will ask you to reflect on your African and Mathematics identities and to present them in a format of your choosing. In the second phase, we will delve deeply into investigating social issues related to African issues that we will decide as a group. We will then meet for two hours weekly (subject to change based on our collective schedules) to study the issue. In the third phase, we will reflect on the process and discuss if and how we used mathematical knowledge. I anticipate that we will work together on this study until the end of April 2019. Your full participation in all sessions will be vital and appreciated in this study. All sessions will be observed and video-recorded during the project. Meeting spaces will be in appropriate locations at Michigan State University or within a reasonable location that will be easily accessible by everyone.

3. POTENTIAL BENEFITS

You might benefit personally from being in this study because this study will provide a space to really investigate social issues you care about and not an issue that has been presented to you. In addition, other people might benefit from this study because of the new knowledges that will be developed in this study.

4. POTENTIAL RISKS

Potential risks in this study might include sadness and anger that could arise from the social issue investigation. However, care will be taken to ensure that the sadness and anger felt can be discussed and that even in this anger and sadness, we can still find joy.

5. PRIVACY AND CONFIDENTIALITY

Consent forms will be stored in a locked file cabinet in a locked office accessible only the primary investigator for three years after the close of the project. All electronic data collected in

the study, along with physical documents (which will be scanned) will be stored on the secondary investigator's password-protected personal computer for three years after the close of the project. All reports of the study will use a pseudonym for you.

6. YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW
Participation in this research project is completely voluntary. You have the right to say no. You may change your mind at any time and withdraw. You may choose not to answer specific questions or to stop participating at any time without consequence. Whether you choose to participate or not will have no effect on your grade or evaluation.

7. COSTS AND COMPENSATION FOR BEING IN THE STUDY
You will be compensated by being in this study. You will receive an Amazon gift card worth $75. You need to participate in the full study to receive compensation. In addition, refreshments will be available during all of our sessions together.

8. CONTACT INFORMATION
If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the MSU faculty member Dr. Beth Herbel-Eisenmann (bhe@msu.edu) or the graduate student researcher Molade Osibodu (mosibodu@msu.edu, 517-775-0190).

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

9. DOCUMENTATION OF INFORMED CONSENT.
Your signature below means that you voluntarily agree to participate in this research study.

_____ _____
Signature Date

You will be given a copy of this form to keep.

Permissions (check the appropriate box & sign)

PERMISSION TO COLLECT ANY ARTIFACTS DEVELOPED

❑ I DO GIVE PERMISSION voluntarily to allow the researcher to collect any artifacts (written or otherwise) developed in all group sessions. The **digital copies will be kept on password-protected computers.**

❑ I do NOT give permission to allow the researcher collect any artifacts.

Signature _____Date_____

PERMISSION TO AUDIO

❑ I DO GIVE PERMISSION voluntarily to allow the researcher to audio me during all group sessions. The **digital copies will be kept on password-protected computers.**

❑ I do NOT give permission to be audio recorded.

Signature _____Date_____

PERMISSION TO VIDEO

❑ I DO GIVE PERMISSION voluntarily to allow the researcher to video me during all group sessions. The **digital copies will be kept on password-protected computers.**

❑ I do NOT give permission for my face to appear in videos.

Signature _____Date_____

WHO CAN SEE THE ARTIFACTS, AUDIO, AND VIDEOS (check **ALL** boxes to which you agree & sign)**:**

I also voluntarily agree to allow the videos to be used for:

❑ **Presentation at professional meetings or professional journals**

Why? A picture is worth a thousand words. Still picture clips and video can often help show what you are doing and learning better than descriptions.

When used for this/these purpose(s), the researchers will protect my identity by never using my names. I can withdraw this permission at any time.

Signature _____Date_____

PERMISSION TO ENTER AUDIO AND VIDEOS INTO ANALYSIS PROGRAM

In addition to the above consent, the researchers request permission to upload videos to a secure and encrypted web-based analysis program only for the purposes of analysis. **Only the researchers of this specific study would be given access** to the study on this website**. Real names would never be used on this site**. If you have any questions, please contact Molade Osibodu (mosibodu@msu.edu). Technology advances now make it possible to look for patterns in information from videos and other collected information (such as tests or transcripts). Molade Osibodu would find it helpful to use such a software program that runs on a secure, encrypted website (for example, www.dedoose.com).

❑ I DO GIVE PERMISSION for audio and video of me to be uploaded to a secure and encrypted website for the purposes of analysis. I can withdraw this permission at any time.

❑ I do NOT give permission for audio and video of me to be uploaded to a web-based analysis program.

Signature

_____Date_____

APPENDIX B: IRB Approval

MICHIGAN STATE
UNIVERSITY

EXEMPT DETERMINATION

October 29, 2018

To: Beth Ann Herbel-Eisenmann

Re: **MSU Study ID:** STUDY00001603
Principal Investigator: Beth Ann Herbel-Eisenmann
Category: Exempt 2
Exempt Determination Date: 10/29/2018

Title: EMBODYING UBUNTU AND INVOKING SANKOFA: A CO-EXPLORATION OF SOCIAL ISSUES AND CRITICAL MATHEMATICS EDUCATION WITH AFRICAN NONIMMIGRANT YOUTH

This study has been determined to be exempt under 45 CFR 46.101(b) 2.

Principal Investigator (PI) Responsibilities: The PI assumes the responsibilities for the protection of human subjects in this study as outlined in Human Research Protection Program (HRPP) Manual Section 8-1, Exemptions.

Continuing Review: Exempt studies do not need to be renewed.

Modifications: In general, investigators are not required to submit changes to the Michigan State University (MSU) Institutional Review Board (IRB) once a research study is designated as exempt as long as those changes do not affect the exempt category or criteria for exempt determination (changing from exempt status to expedited or full review, changing exempt category) or that may substantially change the focus of the research study such as a change in hypothesis or study design. See HRPP Manual Section 8-1, Exemptions, for examples. If the study is modified to add additional sites for the research, please note that you may not begin the research at those sites until you receive the appropriate approvals/permissions from the sites.

Change in Funding: If new external funding is obtained for an active study that had been determined exempt, a new initial IRB submission will be required, with limited exceptions.

Reportable Events: If issues should arise during the conduct of the research, such as unanticipated problems that may involve risks to subjects or others, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants that may change the level of review from exempt to expedited or full review must be reported to the IRB. Please report new information through the study's workspace and contact the IRB office with any urgent events. Please visit the Human Research

Office of Regulatory Affairs
Human Research Protection Program

4000 Collins Road
Suite 136
Lansing, MI 48910

517-355-2180
Fax: 517-432-4503
Email: irb@msu.edu
www.hrpp.msu.edu

Protection Program (HRPP) website to obtain more information, including reporting timelines.

Personnel Changes: After determination of the exempt status, the PI is responsible for maintaining records of personnel changes and appropriate training. The PI is not required to notify the IRB of personnel changes on exempt research. However, he or she may wish to submit personnel changes to the IRB for recordkeeping purposes (e.g. communication with the Graduate School) and may submit such requests by submitting a Modification request. If there is a change in PI, the new PI must confirm acceptance of the PI Assurance form and the previous PI must submit the Supplemental Form to Change the Principal Investigator with the Modification request (available at hrpp.msu.edu).

Closure: Investigators are not required to notify the IRB when the research study can be closed. However, the PI can choose to notify the IRB when the study can be closed and is especially recommended when the PI leaves the university. Closure indicates that research activities with human subjects are no longer ongoing and have stopped. This means there is no further interaction or intervention with human subjects and/or no further analysis of identifiable private information.

For More Information: See HRPP Manual, including Section 8-1, Exemptions (available at hrpp.msu.edu).

Contact Information: If we can be of further assistance or if you have questions, please contact us at 517-355-2180 or via email at IRB@msu.edu. Please visit hrpp.msu.edu to access the HRPP Manual, templates, etc.

Exemption Category. Please see the appropriate research category below from 45 CFR 46.101(b) for full regulatory text. [1][2][3]

Exempt 1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Exempt 2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Exempt 3. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if:
(i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the

confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

Exempt 4. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Exempt 5. Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

Exempt 6. Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

[1]Exempt categories (1), (2), (3), (4), and (5) cannot be applied to activities that are FDA-regulated.
[2] Exemptions do not apply to research involving prisoners.
[3] Exempt 2 for research involving survey or interview procedures or observation of public behavior does not apply to research with children, except for research involving observations of public behavior when the investigator(s) do not participate in the activities being observed.

APPENDIX C: Sample Medicinal Plants

Figure 21. Isikholokoto plant

Figure 22. Agathosma ovata plant

Figure 23. Iphewula plant

Figure 24. Gold carpet plant

APPENDIX D: Youth-generated Survey

Below are the questions for the survey developed using the survey website Qualtrics.

Thank you for taking the time to complete this survey. We seek to understand African youth's views on traditional medicine versus manufactured (western) medicine. Please be as detailed as you can in your responses. The results are anonymous.

1. What is your age?
2. What country did you grow up?
3. What do you define as traditional medicine?
4. What do you define as manufactured medicine?
5. Have you ever used traditional medicine? (for ex. herbs, tree bark, shea butter, etc)
6. When was the first time you remember being given traditional medicine?
    a. Please share examples
    b. Who introduced it to you? (for ex. Grandma, mother, uncle, etc)
7. Do you still use traditional medicine? Why?
    a. Yes
    b. No
8. Have you ever used manufactured medicine? (for ex. paracetamol)
    a. When was the first time you remember being given manufactured medicine?
    b. Please share examples
9. Who introduced it to you? (for ex. Grandma, mother, uncle, etc)
10. Do you still use manufactured medicine? Why?
    a. Yes
    b. No
11. Which are you more likely to consider? Why?
    a. Traditional Medicine
    b. Manufactured Medicine
    c. It depends
12. Which would you pass down to your children? Why?
    a. Traditional Medicine
    b. Manufactured Medicine
    c. It depends

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