EXAMINING HOW YOUTH OF COLOR ENGAGE YOUTH PARTICIPATORY ACTION RESEARCH TO INTERROGATE RACISM IN THEIR SCIENCE EXPERIENCES

By

Takumi C. Sato

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ABSTRACT

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While many researchers have worked to address the unequal educational outcomes between White and non-White students, there are few signs of progress for people of color seeking entry into a STEM career trajectory. Starting from high school, the number of students who persist to complete a STEM bachelor's degree and obtaining a job in science or engineering continues to indicate that people of color are underrepresented. I suggest that research must consider the role of race and racism in the education of youth of color. Especially in science education, there is very little work addressing how racism may present barriers that impede progress for students along the STEM trajectory. This study is informed by critical race theory (CRT) that posits racism is endemic in society. White privilege enables the dominant group to maintain inequitable advantages that marginalizes populations of color. CRT also puts forth that counter narratives of the marginalized groups is essential to challenge the institutionalized forms of oppression. Using CRT and youth participatory action research (YPAR), this investigation re-imagines youth as capable of transforming their own social and political condition through research and action.

This project asked youth of color to interrogate their own experiences as science learners, engage in research on structural inequities of STEM trajectories, plan strategic moves to challenge power structures, and take action for social justice. The youth started by exploring the concept of race and instances where racism was found in public spaces and in their personal

experiences. They examined their experiences in science as a student more generally and then for racism. Then, the focus turned to conducting research with peers, observing science classrooms in another school, and using online information to compare schools. The youth planned strategic action against the racism they found in the analysis of the data that included conference presentations, using social media to communicate with peers, and teaching a science unit for middle grades peers using lessons that incorporated engaging teaching practices lacking in their student experiences.

YPAR resulted in counternarratives that exposed youth encounters with systemic racism and their efforts to positively change STEM trajectories for themselves and their peers. Through YPAR, youth gained research tools and skills to critically examine the world and expose racism. While schools are purported to be places of equal opportunity for all students to learn and find success, the youth showed that institutionalized racism in schools created barriers to STEM aspirations. By planning and teaching a food and nutrition unit, the youth took aim at the institutionalized racism by taking on the role of teacher and expert while improving the science learning opportunities for their middle grades peers and themselves. In addition, planning the unit enabled the youth to conduct all of the activities before teaching the unit. Thus, the youth supplemented their own science learning. YPAR provided an empowering opportunity to challenge racism along their STEM trajectories and fight for social justice.

Keywords: science education, critical race theory, youth participatory action research, racism

I offer this dissertation as my commitment to honor the hopes and dreams of Dimitri Garland Williams, whose wish was to make the world a better place. I vow to continue to work with youth in the struggle to eliminate racism and inequities in education and society. Dimitri ended his battle with sickle cell anemia leaving this world far too soon at the age of 16 on May 17, 2013. Dimitri expressed to his best friend, Lil c, that he wanted to do as much as possible including working with us in projectERASE before undergoing a bone marrow transplant knowing the risk associated with the procedure. In the time Dimitri spent with us, he made priceless contributions to our project to make the world a better place. Dimitri provided the idea and design behind the last lesson of the teaching unit for the younger members of the youth center that is the focus of Chapter 6. Dimitri proposed that we wrap up the food and nutrition unit with a celebratory meal chosen and prepared by the younger peers. They created a healthy menu applying their learning from across the food and nutrition unit. Fittingly, his best friend was the lead teacher for the last lesson. In addition, Dimitri and Lil c co-authored the script for a radio public service announcement that encouraged peers to pursue their college aspirations. May he rest in peace knowing that he has touched the lives of those associated with the project and positively impacted the lives of the youth who benefited from his contributions.

ACKNOWLEDGEMENTS

I have numerous acknowledgements to make in recognition of all those that offered support and guidance throughout my five-year journey represented in this dissertation. Endless love and support from family, friends, and faculty have sustained me toward the completion of my doctoral program.

Adrienne Marie Sato, my loving better half, sacrificed her own career opportunities in order for us to move to Michigan so that I could complete a doctoral program at my preferred university. Unable to find work locally, Adrienne traveled for five continuous years with occasional but all too brief stays at home between contracts. I thank Adrienne for her endless love despite my decision that forced her into exile for five long years.

My mother, Junko Sato, has devoted her life to making sure I have opportunities she never had. My mother instilled early on that I would get a doctorate although I hadn't considered that it would come this much later in life. Through all the hardships including those she endured individually, she has remained steadfast in making sure I obtained the education necessary to have a better life. My mother has worked six days a week in a job that never produced a paycheck for far too many years. Her only income has been tips and her own entrepreneurial efforts on the side to sell baked goods and handcrafted items. My mother made certain that I completed my education to escape the labor-intensive family-owned restaurant business.

Likewise, my father, Kinichi Sato, has worked tirelessly for far too long still going to work daily in his early 70s. With my mother, the two have kept the restaurant business open for business six-days a week for as long as I can remember. By nature of the work, the seventh day has always been a working day as my parents use the day in preparation for the following week. My father instilled that I had to work for everything in life and to pay attention to details. I spent

most of my childhood in my parents' restaurant working and learning the finer points of dishwashing.

I am fortunate to have so many great friends that have been supportive throughout this adventure. Collectively, they have provided endless encouragement and proved to be worthy commiserating partners while helping me stay on track. Friends have also been an important outlet inviting me to step away momentarily from the intensity of academic work and have brought levity to my life.

As for faculty, I am fortunate to have worked and learned from many brilliant individuals through my graduate school experience. And there are many more I wish I had crossed paths with to soak up their wisdom. Perhaps the most important people in my experience in graduate school are the people that know everything. I am referring to the office staff with whom I would have been lost if they were not around. I do wish to acknowledge my dissertation committee members individually for their commitment to my success and opening my horizons on my journey.

My dissertation chair, program advisor, and friend, Angela Calabrese Barton, has been the foundation that has guided my growth and development as an academic scholar. I have been fortunate to find an advisor that devotes 150% of her time to graduate students and is still able to find time to be extremely productive. I have been spoiled with the level of support I have received as a graduate student from Angie. From regular advising meetings to opportunities to work on amazing projects like GET City and going out of her way on so many occasions on my behalf, I am a lucky graduate student. Angie pushed me to view the world critically to understand the complexities of what we mean when we say that we are committed to equity and social justice issues in science education.

I will always remember Andy Anderson as the faculty member that essentially welcomed me to graduate school. I recall visiting Michigan State University as a prospective student and then attending the NARST Annual Conference a few weeks later. I was a lost, first time conference attendee and the only student from my previous institution when I ran into Andy. He still remembered me and checked to see how I was doing. Once I arrived at MSU, I quickly recognized that Andy was not simply recruiting but a very genuine a person. In addition to being high accomplished in science education and teacher preparation, I recall the countless times in research meetings when Andy asked, "Takumi, what do you think?" Andy was very good about including all of the graduate students in the conversations. He created space for me to be challenged intellectually and feel valued in the group. Andy also pushed me to rethink science teaching and what good teaching looks like in schools.

I thank Dr. Dorinda Carter Andrews who introduced me to Critical Race Theory, for providing me with a lens through which to understand my experiences as an Asian American growing up in the US. In Dr. Carter's class, I was able to make sense of what I had experienced and what is still taking place around us in schools and society. Dr. Carter gave me a tool with which I have been able to understand the systemic nature of racism in society and education. I will forever admire Dr. Carter's ability to shape her hard-hitting message about race in ways that fit her audience.

Dr. Django Paris's work on humanizing research has been tremendously influential on my entire approach to working with participants. I am constantly asking myself whether I am engaging research in the best interest of my participants. Dr. Paris's arrival at MSU was timely and extremely fortunate for me, as the humanizing approach has helped me to stay grounded working alongside my participants rather than from afar.

I extend a heartfelt thank you to the leaders and staff at the youth center. This dissertation would not have been possible without the open access I was granted at the youth center where much of this work took place. The entire team at the youth center was beyond accommodating as they provided me with space to engage youth in YPAR and said yes to any and all of my requests.

Finally, I owe a tremendous amount of gratitude to the youth who engaged with me in this groundbreaking research. Malcolm, Justice, Lil c, Caesar, Deelilah and all of the other youth who participated in different capacities have been an incredible source of inspiration to continue pushing for social justice. I thank the youth for giving me a chance to work with them. I hope that my participants have gained as much as I have from our collaboration and that they find themselves ready to pursue their educational aspirations.

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CHAPTER 1

INTRODUCTION

Malcolm, an African American male high school senior, like all of his peers has hopes and dreams for the future. Malcolm aspires to go to college and become an engineer. Those that know Malcolm describe him as bright, hardworking, and an all-around great young man. After a full day at school, he works daily as a junior staff member at the local youth club. He also coaches the middle grades youth basketball team at the club and frequently talks about how he loves to work with the younger kids and sees his potential to be a role model. If he's not coaching or working, Malcolm enjoys spending time playing basketball or video games with his friends. He manages to find time to play percussion with the school band as well as remain active with his church youth group. By most accounts, Malcolm has a bright future ahead and offers several appealing qualities colleges seek in their applicants.

I met Malcolm a year ago between his 11th and 12th grade years through an informal science program for youth in grades 5-8 hosted at a local youth club. I was an adult leader for the program, and Malcolm was a former participant. Given his history with the program and interest working with youth, he was hired to work as a youth leader during the two week summer session of the science program focused on green energy issues. During the summer session, Malcolm displayed his talents including the use of technology. He used Google Sketch Up to design a 3-D building design template that we would later have the younger participants use as the foundation for their work to develop a green building. Malcolm presented the template to the younger kids and was a terrific mentor assisting the youth throughout the session.

Working closely with Malcolm allowed me to ask about his desire to be an engineer and how he planned to reach his goal. I asked what he had done thus far to prepare to study

engineering in college. He listed off several colleges he would love to attend, but I noticed he didn't really share a plan. I imagined that Malcolm would have a busy fall completing applications for admission and was in great shape to be admitted to any of the schools he had named. But, I was horrified and saddened by what I discovered. Malcolm revealed that he had not taken either the SAT or ACT college entrance exams nor was he registered for an upcoming test date or preparing for them. His cumulative grade point average was around 2.0 although he was quick to add that he was doing much better than he had early in high school. I asked if he had ever met with his guidance counselor to map out a plan to get to college and into an engineering program only to find out that the only time he ever saw a counselor was to fix scheduling problems on occasion at the beginning of a term. Malcolm's story is not unique and is the very reason this investigation is necessary expose the systemic ways the same educational system that is meant to support hopes and dreams all too often extinguish the aspirations of youth of color. That is, the system continues to leave students of color woefully behind in the process of getting to college, of getting the support needed to be in a better position to get into the college of choice, and to have STEM learning opportunities to fulfill aspirations.

I continued to catch up with Malcolm around the club after the summer program and would periodically ask whether he had made plans to take the SAT or GRE. He would mention he was looking into it without offering many details. I gave him a few test prep books hoping that maybe having those at home would at least help him see the format of the exams and be able to do some practice questions. I offered to sit down with him and look over test taking strategies if he wanted. When school started in the fall and Malcolm entered his senior year, I asked what science class he was taking given my involvement with the informal science program and his vision to become an engineer. Given what I had already learned, I was not nearly as surprised but

heartbroken to learn that he was not enrolled in a science class. On a more positive note, he mentioned that the seniors at the school would receive some form of test preparation and would take the ACT exam. Unfortunately, the ACT was given to the seniors in the spring semester well after most college application deadlines had passed.

After not having science in the fall, Malcolm enrolled in physics during the spring semester of his senior year. I was pleased to hear that he was in a science class, but I knew that high school students at other schools that had already applied to engineering programs in college were also more than likely enrolled in Advanced Placement (AP) Physics or other advanced sciences for the full year. I asked Malcolm what he was learning in physics and whether they did a lot of labs. He stated that the class did not do labs. Most of the time was spent taking notes. I probed as to why he thought his class didn't do labs. Malcolm had rationalized that his class didn't do labs because they were not in a science classroom with the proper equipment. The class met in a regular room although the teacher had never declared why they did not do labs.

As a senior, graduation is around the corner that will soon mark the end of one chapter in Malcolm's life and begin the next. While I am certain there will be graduation parties and various celebrations to fill the summer, I worry about the fall. Will Malcolm attend school at the local community college and develop a strategy that will enable him to transfer to a four year school with an engineering program? Will anyone support Malcolm to navigate the system so that his dreams do not die at the end of high school while he is still teenager? Caesar, Malcolm's younger brother and high school freshman also wants to be an engineer. Will Caesar get the necessary guidance along the way, or will he find himself in the same place as his brother in three years? And how is it that a bright, talented young man can go through high school with hope and dreams only to graduate without any plans for further schooling?

I imagine there are many young people with Malcolm's experiences in our schools. The limited opportunities for youth of color in school science (Oakes, Ormseth, Bell, & Camp, 1990) and the underrepresentation of minorities in STEM fields (NSB, 2012) has been well documented. The National Action Council for Minorities in Engineering (Frehill, DiFabio & Hill, 2011) reported that the number of African Americans receiving an engineering degree peaked in 2000 and since 2005 has been steadily declining. In relation to the NACME report, we see that Malcolm wants to be an engineer but due to various barriers placed in his way he is denied for now the opportunity to do his part to change the outlook for African American engineering graduates. The goal of this study was to invite Malcolm and his peers including his brother, to interrogate their own schooling, especially in science, and create a space from where the youth can seek power to transform their experiences and their futures. Drawing from the expressed career interests of the participants, exploring the pathways and barriers into Science, Technology, Engineering and Mathematics (STEM) and STEM related fields provides a starting point for this work. I was fully intertwined in this study as a participant while carrying out a research agenda. I worked *with* the participants to support their work as youth researchers investigating and taking action against the forces that marginalize youth of color. Simultaneously, I looked at how the participants took on opportunities to research the inequities in schooling experiences with a specific focus on trajectories and pathways in to STEM fields. The project sought social justice for the participants in this project and more ambitiously to positively affect the opportunities for other youth of color especially those pursuing STEM pathways. That is, how can our work transform science education to insure youth of color have the necessary opportunities and support necessary to realize possibilities and attain STEM trajectories?

For my part as a researcher, I considered how race and racism come into play in Malcolm's story and those student's of color like him. I started with the belief shared with critical race scholars that racism is endemic to society. Yet, racism is rarely discussed in science education research as a way to understand how race impacts student learning and achievement in our schools. There is a growing body of literature that draws attention to disparities in performance measures between races, advocates for improved teacher response to culturally diverse student populations, interrogates the conditions of urban schools with high failure rates, reports on the lack of racial minority college students majoring in science, and work that seeks to reform the way science is taught as a means to close the unequal educational outcomes. While many significant contributions have been made in the field along these topics, racism has for the most part eluded the science education literature. Furthermore, there is a need for research that addresses the way science education both provides and limits possibilities for STEM careers among students of color.

Research Questions

The purpose of this study was to investigate how making race and racism explicit can be empowering for youth to understand their own experiences and challenge the way science learning can pose barriers to potential career trajectories. I wanted to know what happens when youth are supported, have access to resources, and offered a way to critically analyze race and racism in school science through youth-led research.

This investigation was designed to answer the following questions:

1. How do youth of color talk about their experience with school science?
2. How does racism in high school affect STEM trajectories?

3. How do youth engage youth participatory action research to navigate barriers to STEM trajectories?

CHAPTER 2

LITERATURE REVIEW

This study draws from the literature across several areas and is organized into three main parts: (1) the historical overview of how racism has been systemically embedded into education through policy; (2) the body of research on students of color and the STEM pathway; and (3) the research on science education for diverse learners. In order to set up the review of race in science education, I first provide an introduction to the social construction of race and the role of science in that creation.

Science and the Construction of Race

Indeed, there is great irony in that science had a historical role in the creation of race as a construct that has led to the continued oppression of people of color. To be clear, race has no biological merit. Yet, scientific research was used to establish difference among groups of people for the purpose of establishing superiority of fair-skinned, European descendants and false justification for the mistreatment of people of color. For example, craniometry, the study of cranial measurements, was used to suggest larger skulls allowed for larger brain capacity and thus superior intellect. In one such study by Samuel George Morton, it was reported that Caucasians had larger skulls than Indians and Negroes (1839). Craniometry was followed by studies that attempted to classify people by intelligence fueled by biological determinism, the idea that traits are predetermined by heredity (Gould, 1996). According to Gould (1996), Lewis Terman through his studies of IQ, promoted the idea of innate intelligence and argued Negros could not be helped through education. Terman went so far as to suggest racially inferior races should not be allowed to reproduce but realized the impossibility of enforcing eugenics given what he deemed to be prolific ability to produce offspring (Gould, 1996). More recently, similar

ideas suggesting differences in IQ between races was genetic appeared in the controversial book, *The Bell Curve* by Richard Herrnstein and Charles Murray. Gould (1996) successful refuted all of these works, *The Bell Curve* included, on the flawed ways the studies were carried out. Despite the fact race is a social construct and science disproved many racially charged studies, the damage inflicted by scientific racism is persistent in a system of oppression that continues to victimize people of color.

Historical Overview of Racism in Education

I provide a brief overview of different structures that ultimately impact opportunities for youth of color to reach their college and career aspirations. Critical race theory, described further in the conceptual framework section that follows, points out that racism is systemic. In other words, racism is built into the structures of society. As such, we must also consider the history of policymaking that has contributed to the structures of oppression in education. The following is not meant to be a comprehensive review, but rather a selectively identified set of factors that impede the pathway of students of color wanting to enter STEM fields. I will address examples of the broader social policies (redlining), funding structures of public schools, education policy (No Child Left Behind), and school/classroom policies and the ways each contributes to the structure that denies opportunities to students of color through their schooling experiences.

Redlining. The historical perspective and analysis of education and non-education policy has illuminated ways that certain decisions have led to what amounts to sanctioned marginalization of populations of color with lasting impact on education. For example, the practice of redlining to discriminatory mortgage lending practices in real estate have led to detrimental impact on populations of color and educational opportunities. Redlining was the practice used by realtors to identify parts of a city that were "less desirable" due to the

demographic distribution (Massey & Denton, 1993). Basically, the maps marked in red ink identified areas with large populations of color. Thus, certain areas were marketed to White homebuyers and effectively kept people of color out of these neighborhoods. The realtors and White homeowners believed selling to buyers of color would bring down their property values and desirability of certain neighborhoods. Likewise, the maps limited housing options for buyers of color even if they could afford a home in a White neighborhood. The result in many large cities was the "ghettoization" of urban areas as large concentrations of people of color where forced into cramped and substandard housing conditions.

While redlining is less blatant today, the newer phenomenon of *reverse redlining* has continued a history of discriminatory real estate practices (Squires, Hyra & Renner, 2009, Lichtenstein, 2009). Some real estate analysts attribute at least in part the current economic downfall to unscrupulous mortgage lending practices that targeted racial and ethnic minorities and pushed them into subprime loans (Aleo & Svirsky, 2008, Fisher, 2009). With little risk to mortgage brokers who collected commission from lenders, first time homebuyers of color were often not told by their lender and as result did not know that they in fact qualified for more conventional fixed rate mortgages were pushed into riskier variable rate loans. With the riskier loans, unexpected large increases in the interest rate caused many buyers of color to suddenly find that they could no longer afford the monthly mortgage payments leading to defaulting on the loan and the real estate fallout. Furthermore, having to declare bankruptcy or having a home repossessed has damaging long-term impact on credit worthiness ratings for these buyers of color. We can see how discriminatory real estate and mortgage practices have contributed to the dense concentration of populations of color in urban areas in what can be considered de facto segregation with implications on schooling for students in these areas.

In the small city where this project takes place, we see high rates of segregation compared to population statistics for the state of Michigan and parallels similar concentration of people of color in geographic areas. Of the total population in Michigan, 79% are White and 14.2% Black or African American and only 11.8% Black or African American at the county level (US Census Bureau, 2010). But, if we look at the two census tracts where the youth center and school that participants attend are located along with two adjacent tracks, we see that these areas are only 50.9% White and 32.6% Black or African American. One of the tracts shows a majority minority with 47.9% Black or African American and only 32.4% White population. While it is not completely clear whether redlining has created such local demographic conditions, we do know that there are similarities in housing patterns to other urban areas.

School funding. Funding structures of public schools are largely based on property tax revenue (Hanushek, 1991). The discrepancy between urban districts with majority minority populations and suburban districts with majority White populations becomes pronounced in the fallout of the real estate crisis. I am not suggesting suburban school districts have been exempt for the impact of the economic downturn but rather that the problems are more compounded in urban districts. The impacts are felt from teacher recruiting and retention to materials and resources available to the schools. In general, suburban school districts are able to offer what are often considered more attractive teaching opportunities in well resourced schools with a competitive salary and benefit from their pick of qualified applicants leaving the least qualified teachers to teach in urban schools with large minority populations (Lankford, Loeb & Wyckoff, 2002). In urban districts, even basics needs in a school like heating in the winter get neglected (Matsuda, 2006) making it harder to recruit and retain quality teachers or enable students to focus on learning when they are worried about staying warm. Urban centers that are seeing a

decline in population and increase in foreclosed homes continue to suffer from a shrinking tax base. The result is the maintenance of the educational disparities between youth of color and their White counterparts often due to policies and practices outside of education as we see here with real estate and property taxes.

It needs to be noted that the school funding structure in Michigan is not based on property taxes but rather sales taxes and other revenue after the passage of Proposal A in 1994 (Courant, Berry Cullen & Loeb, 2003). The proposal allowed for 60% of the 4% sales tax to be directed to the School Aid Fund and added another 2% sales tax of 100% would go to schools. The change from property taxes often collected through locally determined millages to a statewide sales tax formula also shifted the control of funds to the state legislature. Additionally, the Proposal A moved toward a more equitable per pupil funding structure across the state establishing a minimum rate. Prior to the implementation of the proposal, the disparity in spending per pupil was much greater when property taxes meant those in affluent areas benefited by as much as $7000 per student (Bessette, 2006). Unfortunately, an economic depression has consequences on schools especially those in urban areas that serve students of color. First, the school funding is now a state budget item, and in an economic downturn it can significantly slash money to schools. Not only do schools have to compete with other government interests for funding, decreased consumer spending leads to less sales tax revenue. Additionally, urban centers that see declines in population during economic strife lose students and thus funding that is based on per pupil counts (Arsen & Plank, 2003). Second, funding for categorical aid such as special education is much more at-risk of being cut by the state. Categorical aid is significant because schools that serve disadvantaged communities are more likely to lose funding for these essential

programs. Schools are also restricted in their ability to raise capital funds meaning increased strain on being able to maintain and update physical structures.

The point is that school funding structures continue to marginalize schools that serve populations of color. While I have provided a brief overview of general property tax based funding and the sales tax based structure in Michigan, the funding disparities are much more complex and have wide reaching impacts including the ability of schools to update resources to paying for quality teachers. I should also mention that in Michigan, Proposal A also saddled the school districts with the burden of retirement funds for its teachers (Bessette, 2006), further complicating school finances.

Social class and tracking. Race often intersects with other social markers such as class. Simply looking at funding structures is not sufficient to understand the systemic ways in which the disparities between schools with predominantly youth of color and their majority White counterparts is exaggerated. If we consider Bourdieu's (1973) theory of social reproduction, we see how those in power retain their power and those who are subordinate remain in their place in the social structure. The most obvious way social reproduction plays out in US society is the maintenance of class structures. The theory maintains that class structures are set up and replicated in a way that insures those at the top will be in power, but there needs to be a middle class to maintain the illusion of social mobility, and that society will always need a lower predominantly working class to serve the needs of the classes above them. The upper class, most often White are positioned as elite, wealthy and powerful, continue to reap the benefits of social reproduction. For example, the wealthy have resources unavailable to others to assist their children successfully navigate the school system. Whether to hire a private tutor, provide the latest technology to support learning, gaining experience through travel, or matriculating at top

university through legacy, the upper class has means not available to the middle and lower class. Likewise, the middle class is maintained by the notion that by subscribing to the dominant narrative of self-determination that they too can eventually join the upper class. Unfortunately, the rich get richer exacerbating the gap between the upper and the other classes. Race and social class are interconnected by the structures and practices including the previously described real estate market and school funding structures that continues to relegate people of color to the lower classes. Furthermore, meritocracy, an ideology build on notions that people are socially positioned based on merit, is legitimized by capitalism (Bowles & Gintis, 1976). In what came to be known as Social Darwinism, an application of Darwin's theories to social spheres, suggests that *only the victims are to blame* for their deplorable condition by failing to take advantage of the meritocratic system (Dennis, 1995) Yet, the meritocratic system is a farce when examining the ways people of color are most often the victims and repeatedly denied equal opportunities to success and social mobility.

If we consider race and class in education, we quickly see that marginalization in broader social spaces is extended into the schools often in the form of tracking. Schools often create separate opportunities for students based on academic and behavioral factors to track students into different trajectories. As a result, students of color are more likely to be placed in a lower track than their White counterparts. For example, Oakes et. al. (1990) reported on the ways in which race and class are often significant factors in math and science learning opportunities. Minority students from low-income backgrounds are more likely to be placed in low-ability classes as early as elementary school. As students move on to secondary school, as mentioned above, teachers in low-income, high minority population schools are less likely to be certified in the subject area they teach. Furthermore, teachers are less likely to use practices like inquiry

learning and develop problem-solving skills in classes with low-ability students. As a result, Oakes et.al. (1990) concludes that youth placed in low-ability classes continue to be disadvantaged from an early age. Through this continued marginalization by race and class, those already at the bottom are kept at the bottom and are less likely to be in position to pursue college and career aspirations.

Oakes (1992) identified the existing challenges to ending tracking practices including technical, political, and normative. Gamoran (2009) describes the technical challenge faced by teachers to instruct students of mixed abilities within one classroom space, the political challenge from parents and teachers wanting to maintain tracked classes, and the normative challenge of widespread beliefs that students do vary in ability and thus schools should be designed to meet the needs of those differences. Despite the challenges, efforts have been made toward detracking and changing the way tracking disadvantages select racial and social group with mixed results. For example, Watanabe (2007) explored teacher perspectives on detracking and reported that there are discrepancies on what is considered tracking and how much tracking exists in schools. Teachers in a school allowing student choice in selecting courses responded to the question of tracking in their school along the spectrum of no tracking to the full. On the extremes, some teachers felt that choice meant there was no tracking while others felt that students lacked genuine choice. Mickelson & Everett (2008) described neotracking in North Carolina whereby students were given choice in the 8th grade to select a track for high school, the Course of Study Framework (COS). The move was precipitated by the *Leandro* vs. State of North Carolina (1997) case in the state Supreme Court upholding the obligation of schools to provide a "sound basic education" for all students. The court decision and other forces including labor leaders calling for the preparation of a capable work force for the state resulted in COS reform. Students

chose between Career Prep, College Tech Prep, or College/University Prep Course of Study tracks that were embedded with disciplinary tracking (general, honors, Advanced Placement levels) to form what authors called neotracking. Black and Hispanic students were less likely to choose the more academic College/University Prep COS than White or Asian students maintaining race and social stratification (Mickelson & Everett, 2008).

Policy and science. Education policy also impacts students of color often in negative ways. For example, federal No Child Left Behind legislation while intent on closing the unequal educational outcomes has fallen short by mandating a system of accountability that systematically deprives students of rich learning opportunities and overemphasized standardized testing. Darling-Hammond (2007) criticizes NCLB for allocating resources toward assessment rather than investing in the development of high quality teachers, improving curriculum, and providing schools with needed resources. With federal funding tied to student achievement under NCLB, schools have resorted to the least engaging practices as a way to raise student test scores. The issues related to standardized testing are more acute in underperforming schools, usually serving large numbers of youth of color, resulting in a compromised curriculum (Cawelti, 2006; Settlage & Meadows, 2002. Schools have increased the number of remedial courses and cut non-elective, non-tested courses and elective courses (Cawelti, 2006). Townsend (2002) warned of the dangers when the push toward accountability means more remedial instruction guided by false assumptions that such practices will improve learning for students of color. Perhaps more importantly, uninspired and reduced curriculum especially in science and math work to remove STEM possibilities for students. And with a heavy emphasis on test scores, assessment in response to NCLB becomes a tool to exit students of color from the STEM pipeline and out of schools as I explore below.

Unscrupulous school practices. Schools often engage in unscrupulous practices including one I observed as a high school classroom teacher. In what was termed "spring cleaning", underperforming students were counseled out of high school into alternative programs like evening General Educational Development (GED) certificate programs. Fine (1991) identified how not all students who leave high school before graduation are dropouts as often reported in data but in many cases discharged as pushouts. For example, Orfield et. al. (2004) describe how school would push out the students who were considered academic liabilities to drag down the school standardized test scores as a low cost method to improve school testing results. By "pushing" these students from the school roster prior to the administration of the tests in the spring, the school could create the illusion of an improvement in their achievement scores (Darling-Hammond, 2007). At the high school where I taught, I observed how the counselors set up meetings with the student and parents to get the necessary signatures and explained that the alternative programs were the "best option" given the student's academic record. The parents and students rarely resisted believing that the counselor and school has the best intention and perhaps not fully understanding the implications of exiting high school for an alternative program. Furthermore, the parents were often deferred to the authority of the school figure relinquishing any power they could have used to fight the removal from school. Yet, statistics show that those who do not graduate with a high school diploma earn significantly less income (US Census, 2010) setting up the pushouts for financially limited career options.

Spring cleaning is only one example of how youth of color are marginalized in the school system. For example, youth of color are frequently overrepresented in disciplinary actions in schools and punishment becomes a way down a track toward prison (Ferguson, 2001; Skiba, Michael, Nardo & Peterson, 2002; Gregory & Weinstein, 2008; Hilberth & Slate, 2012). Thus,

the school is not a place for youth of color to achieve their dreams but become socialized into a system that marginalizes and predisposes, in particular Black males, into the prison system. Ferguson challenges the way school structures are a powerful force in the future trajectory of students citing incidents of adults in the school blatantly stating their opinions on which student will end up in jail to the ways Black youth are more frequent targets of disciplinary action. Instead of creating pathways for students of color toward STEM opportunities, barriers are placed in the way detouring students from realizing their full potential.

Students of Color and STEM Pathways

If we look more closely at the science education literature, we find that since the report from Oakes et. al. (1990) attention has been directed toward the disparities in outcomes for diverse learners including youth of color. Lee and Luykx (2006) described science outcomes of diverse learners to include "science achievement, attitudes toward science, enrollments in high school science courses, earning of college and graduate degrees in science and engineering fields, and entrance into science and engineering occupations" (p. 13). We know there are gaps in outcomes between learners of color and their White peers but we continue to find that little has changed.

Achievement of diverse learners. Starting with achievement, the National Center for Educational Statistics (2011) study, *The Nation's Report Card: Trial Urban District Science Assessment 2009*, compared the science achievement of 14 participating urban districts and compared their results to the national average of large cities. In most of the urban districts, the student population was majority minority with Black and Hispanic students being the largest groups. The study found that in most cases, the urban districts were below the national average (NCES, 2011). There were a few exceptions particularly with a subgroup within a district scoring

above the national average. Still, the overall report is not encouraging for urban districts where students of color are the majority. And while the average test score has steadily improved for all groups, the gap between Black and Hispanic students persists (Lee & Luykx, 2006).

Secondary students in science. Atwater, Wiggins, and Gardner (1995) examined the science attitudes of middle grades students in a 91% African American school district. The survey indicated almost half of the students were interested in pursuing a science-related career. Riegle-Crumb, Moore, and Ramos-Wada (2011) used 2003 Trends in International Mathematics and Science Study (TIMSS) survey data and found that the math and science aspirations of Black and Hispanic males among 8th grade boys was similar to White males. Yet, positive attitudes toward STEM careers in middle school do not translate to students of color continuing science trajectories into high school and college.

Basu and Calabrese Barton (2007) investigated the relationship between funds of knowledge and sustaining middle grades youth interest in science with Black and Latino/a students in a large urban city. The funds of knowledge that supported youth interest in science included vision for the future, social relationships, and agency. Neil looked to a future as an aspiring artist and used science to help him with ideas for his drawings. Anna had a strong connection with her mother that fostered a caring disposition. She viewed science as something that can be used to help others whether through her aspiration to be a pediatrician or her invention of the Annabar, a healthy candy bar to make others happy. Youth interest in science was tied to agency, or the usefulness of science to the things most relevant in their lives. This leaves the question of how to sustain the role played by funds of knowledge to build interest in science as youth move forward into high school in ways that connect to their lives.

If we look at high school science, most states and schools require students to take biology

and thus students of color are well represented. But if we look at advanced level courses and enrollment in chemistry and physics, students of color are underrepresented (Lee & Luykx, 2006). Atwater, Wiggins, and Gardner (1995) indicate that science attitudes are shaped by many variables including peers, parents, teachers, classroom climate and other factors. Riegle-Crumb, Moore, and Ramos-Vada (2011) suggest that, "we need more research that focuses on understanding how to prevent adolescents from prematurely closing the door on a future career in these fields" (p. 474). I add that we must ask whether the student is closing the door or whether others are closing the door on the students.

Aschbacher, Li & Roth (2010) conducted a longitudinal study of students' science identity and aspirations among high school students originally reporting strong interest in science trajectories to see if they persisted. The participants were grouped into three categories identified as High Achieving Persisters, Low Achieving Persisters, and Lost Potentials. The Lost Potentials were the students who left the science trajectory and included lack of support, poor school experiences with science, the difficulty of science classes and careers, lack of related extracurricular experiences, and other emerging non-science interests. This group also included high percentages of Black and Latino students. High Achieving Persisters on the other hand included 100% of Asian participants and a greater percentage of high SES students. Persisters were more likely to report greater passion for science, positive experiences with science, and greater support including from family and peers.

If we consider the support system for youth in high school, the guidance counselor plays an important role in establishing trajectories. Schmidt, Hardinge & Rokutani (2012) call attention to the ways school counselors can be either gatekeepers or play an integral role in supporting youth into STEM pathways. Counselors need to be prepared to give academic and career advice

as well as provide leadership including the area of actively encouraging and supporting STEM trajectories for traditionally underrepresented groups. In order to achieve these goals, specific training regarding STEM trajectories including career opportunities, academic and skill requirements of the field, and how to best support students through counselor professional development is essential. Patricia Martin from the College Board National Office for School Counselor Advocacy states, "[Counselors] must have the courage to stand up for students who may be unable to stand up for themselves in systems that have produced disparate academic results and thus, few to no postsecondary options for many students in the past" (College Board, 2010, p. 6).

STEM from college to career. According to the National Science Foundation report, *Science and Engineering Indicators 2012*, the number of science and engineering bachelor's degrees awarded to Hispanic students has increased from 7% to 9% but has remained unchanged for Black students at around 8%. The report suggests that while overall college enrollment for all groups has increased as well as the degrees awarded across all fields (including non-science and engineering), there are several factors that are reflected in the attainment of students by race and ethnicity. In particular, students of color are less likely to "graduate from high school, to enroll in college, and to graduate from college" (NSB, 2012).

Workforce data for the US reveals disparities among scientists and engineers by race. In 2008, the science and engineering career field labor statistics showed that the field was comprised of 71.8% White, 3.9% Black, and 4.9% Hispanic employees. When compared to US population demographics by race of 67.6%, 11.7%, and 13.9%, respectively, we see the overrepresentation of White science and engineering workers and an underrepresentation of Black and Hispanics (NSB, 2012).

That leaves the question of what happens between middle grades when students of color often have positive attitudes and aspirations toward STEM careers to the reality of the workforce. And, is race and/or racism built into the pathways for learners of color that we see the progressive decline into high school and college? It would seem that the space between middle school and high school is one place worth exploring.

Science Education for Diverse Learners

A fundamental point of contention among scholars, scientists, and society is the purpose of science education. A popular response is a scientific literacy defined by developing a person who can use content knowledge to understand phenomena around them, engage and evaluate science in the media, be informed take a position on science-based issues, and to make scientific arguments (DeBoer, 2000; AAAS 1989; NRC, 1996). From a sociocultural perspective, researchers have challenged notions of functional scientific literacy questioning whose science is being privileged, challenging who can do science, and expanding how science is communicated. Advocates for a critical science literacy seek a more inclusive understanding that considers the ways science is used to develop knowledge, identities, practices and discourses for transformative purposes especially among marginalized populations (Roth & Calabrese Barton, 2004; Weinstein, 2009; Upadhyay, 2010). In this section, I draw from the literature to provide a few examples of how we might rethink science curriculum, instruction and assessment to develop critical science literacy meet the needs of marginalized students.

Science curriculum. If we consider the science curriculum, one of the critiques argues the materials are not culturally relevant and lacks representations of diverse scientists and students of color (Lee & Luykx, 2006). The curriculum used in schools is built on the ideas of Western science, generally associated with a White male perspective. Students of color often do

not see themselves in the curriculum or feel that the lessons are relevant to their lives leading to disengagement. Aikenhead (1996) argued, "science educators, Western and non-Western, need to recognize the inherent border crossings between students' life-world subcultures and the subculture of science, and that we need to develop curriculum and instruction with these border crossings explicitly in mind, before the science curriculum can be accessible to most students" (p. 2). Bang & Medin (2010) push for developing community-based curriculum to insure that the cultural knowledge of youth of color is brought into the learning spaces. Mutegi (2011) problematizes the notion of *science for all* suggesting that African Americans are not well served by the current curriculum and calls for a socially transformative curriculum that moves toward social and political change.

Science instruction. Science instruction is an important factor in the learning of all students and especially for youth of color. Pedagogies enacted in the classroom with learners of color must be culturally congruent and consider the voices that are privileged. Often science classrooms are built on scientific discourses and deprivilege youth discourse and cultural discourses.. Moje et. al. (2001) describe the way the teacher, Maestro Tomas, works with his seventh grade Latino/a science students using instructional practices that invite different discourses including the everyday discourses of the students rather than only privileging disciplinary and instructional discourses. More broadly, science instruction as it often unfolds in the classroom has been under scrutiny. Anderson (2006) calls for science instruction that is both motivating and builds understanding. Learning must draw from personal experiences and observations and move toward understanding of phenomenon through models and theories. Likewise, understanding requires students to be able to take scientific knowledge and be able to apply it to "describe, explain, predict, or design phenomena and systems in the material world"

(Anderson, 2006, p. 18). That is, science instruction should maintain rigor and high expectations for students. Too often, urban schools are staffed with inexperienced teachers with limited pedagogies that neglect student experiences and knowledge in favor of didactic strategies.

Science assessment. Similar to curriculum and instruction, Lee & Luykx (2006) call for assessments that consider the cultural knowledge and experiences of students of color. Otherwise, the assessment only considers and values knowledge as defined by Western science. Lawrenz, Huffman, and Welch (2001) conducted a study with a nationally representative sample to compare alternative format assessments to more traditional assessments. They used four different assessments including multiple choice, open-ended written response, hands-on content-based laboratory test, and a hands-on full investigation. The results across all four exams found that Caucasian and Asian American students outperformed African American and Hispanic/Latino American students with one exception. On the full investigation, African-American and Caucasian students were equal. The potential of using alternative assessment formats can be beneficial to not only students of color but all learners to be able to apply knowledge and skills rather than only recalling information. But as we see here, if the alternative assessment is based on Western curriculum, then perhaps the results for students of color is not surprising. We must break away from narrow ideas of assessment to imagine new, innovative and racially and ethnically appropriate ways for students to demonstrate understanding of science.

The inequities of education have been written about extensively (Oakes et. al., 1990) including the ways youth of color are marginalized in school experiences through disproportionately low opportunities in science and math. Despite the wealth of literature, we continue to struggle with closing the unequal educational outcomes and increasing the number of students of color choosing STEM pathways. More specifically, science education research and

educational policymakers must understand and pay attention to how race plays out in the classroom and how certain practices can be the tools of oppression that systemically deny youth of color opportunities to pursue pathways into STEM fields. This is particularly true for science education where very little exists that examines race and racism. In the next section, I layout the tenets of critical race theory (CRT) and explore its use (or lack of) in the science education literature.

Conceptual Framework

This study is grounded in critical race theory (CRT) and serves as the lens through which I understand the experiences of racialized and marginalized youth in science learning. I have chosen to use CRT and bring the theory to science education research due to the explanatory power for understanding how race and racism matter and to expand the way we might work toward truly making science for all.

First, I begin by explaining the terms *race* and *youth of color*. Race is a social construct (Ladson-Billings & Tate, 1995). That is, there is no biological evidence for marking differences between human beings. Rather, race has become a tool by which people are separated into groups based on difference often from the dominant group. The differences are usually marked by physical traits most notably skin color. Individuals of African descent are often racialized as Black for usually having darker pigmentation. Likewise, Asians are often racialized by black hair, short stature and "yellow" skin and Native Americans have been referred to as "redskins". In a US context, Whites noted by their fair skin have generally been the dominant group. Further, government policies including census data gathering have sanctioned the use of racial and ethnic markers of difference to uphold that in fact there are differences people despite all being from the same biological species, *Homo sapiens*. Therefore, youth of color refers to students that have

been identified by race as not belonging to the dominant group. That is, youth of color refers to those that are identified in dominant cultural frames as non-White.

Second, I explain the relationship between race and racism as they are used in this dissertation. Distinguishing people by race explicitly works to point out differences between populations based on physical features and is a means for *othering* people that are not of the dominant group. Racism is not simply the act of recognizing differences but rather the use of power structures that are embedded in the construct of race to assert White dominance (Leonardo, 2004). Racism is the act of oppression committed by those with power against people of a different race. In an example from education, White dominance is maintained often through systemic racism found in the official curriculum that effectively maintains a position of power. (Ladson-Billings, 1998).

Critical Race Theory

CRT was first developed in US critical legal studies and later found its way into education as a viable theory to explain and understand how race and racism play out in education (Ladson-Billings & Tate, 1995). Critical legal scholars like Derrick Bell, Patricia Williams, and Mari Matsuda examined the way race and racism where factors in legal decisions within the White dominant justice system. Their work led to the development of CRT which state that racism is: (1) endemic; (2) *White privilege* confers benefits to the dominant group; (3) counternarratives exist that challenge the dominant narratives; (4) *interest convergence* is used to benefit the dominant group; and (5) social justice must be the goal of CRT (Delgado & Stefancic, 2001).

The first tenet of CRT states that racism is endemic despite the fact race is a social construct with no scientific merit (Ladson Billings, 1995). Racism is deeply embedded in the

structures of society. Racism is a tool of the dominant group to marginalize people of color. Racism is enacted at different levels from individual to individual interaction up to policy levels that marginalize entire populations of non-White people. For example, the narrative of education research frequently points to the disparities in academic achievement between White students and students of color. While the reporting of such findings is not racist, the ways the narrative is taken up and acted upon by society can be construed as racist. Schools with large numbers of minority students often implement policies to increase the number of remedial classes (Oakes et. al.,1990) instead of asking how to develop more robust and engaging classes, therefore marginalizing youth of color who are mostly likely to be placed in those classes. That is, opportunities to engage content in a classroom where dynamic interactions through discussion, experiential learning, or other meaningful tasks are replaced with monotonous repetition drills.

White privilege provides members of the dominant group with advantages that are not also available to non-White populations. The privileges afforded by membership in the dominant population are not earned but solely based on race. Ladson-Billings & Tate (1995) described *Whiteness as property* as the ownership of rights that privilege members of the dominant race over people of color. For example, student researchers working with Irizarry (2011) documented instances of White privilege related to hallway monitoring by adults in the school. A White student was more likely to receive a pass from the teacher to exit the room before a student of color during class time. Also, a student of color in the hallway while class was in session was more likely to be stopped in the hallway by school faculty while White students are allowed to pass without question. There was a mistrust of students of color while White students were unquestioned due to White privilege.

CRT recognizes the power and importance of counternarratives that emerge from people of color. Counternarratives tell stories of struggle against a racist system, provide concrete examples of how people of color are marginalized, and also provide a place from which to gain strength in the fight against racism (Delgado & Stefancic, 2001). Contained in these counternarratives are stories to challenge the dominant group. Counternarratives legitimize the experiences of people of color and give voice to refute the grand narratives of society. For example, one of the grand narratives in the US is that this is the land of opportunity where all people regardless of color can achieve the *American dream* and attain success based on hard work alone. But, counternarratives often tell a different story in which people of color are subjected to racism that denies people means to achieve the dream. This is especially true in education where youth are often counseled into less rigorous academic programs. Yet, we also see powerful counternarratives of youth of color who are successful learners in predominantly White schools (Carter, 2008) or youth of color in informal spaces communicating about science through video that lead us to rethink conventional ideas of achievement related to non-White students (Calabrese Barton & O'Neill, 2008).

The tenet of *interest convergence* states that Whites may concede to demands of the oppressed if it also serves the needs of the dominant group. Whites often do what appears to be a gain for populations of color as a self-serving act (Delgado & Stefancic, 2001). For example, the US Supreme Court case of *Brown vs. Board of Education* ended segregation in schools and the decision was championed as a significant advancement for students of color across the country. Yet, critical race theorists argue that considering the ruling in the context of world affairs tells a different story. The relations between the US and Russia were reaching a tenuous point but the US could not challenge communism as long as people continued to be segregated within it's own

borders. Therefore, desegregation becomes an example of interest convergence where the US and White interest was served by the decision preserving a democratic image and allowing for US initiatives to move forward on the global stage. Despite the end of legal segregation, demographics of the US continue to point to high concentration of students of color in urban school districts suggesting little has changed.

Perhaps the most important tenet of CRT is the imperative to move toward social justice. Racism must be confronted at every opportunity and action taken to change the system that continues to oppress people of color. As long as racism persists as a structural feature of our society, we must combat the ways oppression is enacted upon certain groups of people and transform society to be more just. Counternarratives provide a starting point from which legitimize experiences of people of color and to build momentum against oppression. Racism must be named when it happens. Remaining silent for fear of retribution only reinforces the oppressive structures. Furthermore, the effort must be strategic with the understanding that deep seeded racist ideology is difficult to uproot. A sustained effort is necessary over time, as those in power will meet every step with resistance especially if their power is threatened. For example, efforts to introduce school choice and voucher systems to allow students in poorly performing schools to attend higher performing schools are often met with resistance. Often, this meant homeowners voted against school choice measures for fear a decline in property values if the local school became a school of choice (Brunner & Sonstile, 2003). One interpretation suggests that the mostly White suburban homeowners acted against the potential influx of youth of color from urban schools.

In addition to the tenets, CRT also warns against colorblindness (Bonilla-Silva, 2009). Colorblindness is the notion that one does not see color (Wise, 2010). Using a colorblind

perspective enables the White dominant group to in essence preserve the inequities in place against people of color by evading a challenge to the structure. Racism is swept under the rug and disparities are maintained. Rather than bring race and racism to the forefront for substantive discussion, avoidance measures work to preserve inequities by failing to legitimize the concerns of people of color and denying their existence by taking a colorblind stance. Likewise, there is great danger in believing that the US has entered a post-racial era with the election of the first Black President, Barack Obama, by declaring racism no longer exists. People of color continue to live in substandard conditions often due to racism that exists within the system. While President Obama's election is a major step forward, the US is far from eradicating racism.

In order to understand how racism is enacted, we must also recognize that apart from overt examples that are more easily recognized, there are subtler but equally damning ways in which people of color are oppressed. Microaggressions are "subtle forms of racism" (Solórzano, Ceja & Yosso, 2000, p. 60). And, when microaggressions are constantly directed at people of color over time, there is a cumulative, oppressive effect on the victims. So, when a White person says to me as an Asian American, "Oh, you speak English so well. I mean you don't have an accent or anything," is an example of a microaggression. The comment suggests there is a norm for spoken English and those who cannot speak without an accent are inferior. Pointing out my lack of accent suggests that people must conform to the White dominant norms for speaking English in the US. This is compounded by other microaggressions that point out difference when I'm asked whether I know any martial arts, that I don't act Asian, or if I'm good at math and science.

If racism is permanent, then CRT is a useful lens for examining the experiences of youth of color including Malcolm to interrogate how he has arrived in his situation of not having plans

to continue his education beyond high school graduation and to ask if other students have similar experiences. In this study, CRT questions how race and racism have contributed to limited educational opportunities in science that have deferred Malcolm's pursuit of an engineering trajectory and STEM pathways for other participants. Furthermore, how does race and racism affect whether students of color receive the necessary support to get on and navigate the college-bound pathway that can lead to STEM futures.

CRT is also useful to examine participation of the youth as researchers. CRT might offer explanatory power for the ways the youth take on issues of equal opportunity to pursue STEM trajectories. For example, how might CRT help explore youth actions as counternarratives that speak back against the structures that maintain unequal opportunities for youth of color?

Critical Race Theory in Science Education

At the disciplinary level, science education has yet to take on critical race theory (CRT) as an analytical lens for understanding the marginalization of students of color. Scholarship that uses CRT exists more broadly in education research and has branched out to include LatCrit (Alemán & Alemán, 2010, Huber, 2010), AsianCrit (Teranishi, Behringer, Grey, & Parker, 2009), TribalCrit (Brayboy, 2005) and QueerCrit (Loutzenheiser & MacIntosh, 2004). Researchers have acknowledged room for CRT and other lenses to understanding race, ethnicity, and culture within science education research. In a summary of a National Science Foundation sponsored symposium charged with developing a research agenda on the achievement in science of underrepresented groups, Fraser-Abder, Atwater, & Lee (2006) state, "we recognize that additional research paradigms are needed to explore ways to answer some of the age-old questions in science education. Such paradigms should include critical race theory, transcultural theory, and economic theories" (p. 604).

Ladson-Billings & Tate (1995) are often credited for bringing CRT over from critical legal studies and into education. Yet, science education researchers have not responded according to a search for scholarship in journals in the field. In the leading science education journal, *Journal of Research in Science Teaching (JRST)*, a search for "critical race" yields a total of seven articles, none of which applied CRT as the theoretical lens. A search in *Science Education* returns five articles. *Research in Science Education* yielded one article on the topic of peer review suggesting many reviewers are not familiar with new theories including CRT as an example. Likewise, the *International Journal of Science Education* provided one article. Overall, two types of search results categorized the articles located. The articles found in the searches either made a reference to critical race theory or critical race ethnography but did not use CRT as a theoretical or conceptual framework. The rest of the results for "critical race" only yielded a hit because titles within the reference list included the terms. Yerrick & Johnson (2011) do draw more explicitly from CRT, but their article was found in a journal outside of the original search, *Cultural Studies in Science Education*. While CRT or specific tenets of CRT informed the majority of articles found in the search, they didn't necessarily use the language of CRT (Table 2.1). So, that leaves the question of why isn't CRT being used as an analytical tool in science education research?

In a paper by Tate (1999), *Science Education as a Civil Right: Urban Schools and Opportunity-to-Learn Considerations*, he pushes for science education as a civil right that moves beyond equitable sharing of space with White students but to a science that provides that same opportunities and access to rich learning in science that are often still denied to students of color. While race is a factor, Tate (1999) did not use CRT as an analytical lens. The search turned up the article due to a citation in the reference section, but CRT is never made explicit. Rather, as

we will see in other articles as well, elements of CRT are an underlying theme.

Basu (2007) writes about critical agency as a framework in her article, *Powerful Learners and Critical Agents: The Goals of Five Urban Caribbean Youth in a Conceptual Physics Classroom,* and cites critical race scholars Solórzano & Yosso (2001). Basu borrows from CRT and calls for a challenge to the existing power structures found in schools and classrooms as well as stereotypes of marginalized learners. The article uses counternarratives of youth participants but does not go so far as to explicitly name the racism in accordance with one of the major tenets of CRT.

Bang & Medin (2010) write about indigenous students in science in their article, *Cultural Processes in Science Education: Supporting the Navigation of Multiple Epistemologies.* The authors cited work by Hermes (1999) that appeared in an edited volume on CRT and research methodologies for indigenous populations. Bang & Medin (2010) draw from the literature on research methodologies to inform their own development of the methodologies section to challenge the conception of science in a White dominant society and to loosely point toward the CRT tenet of counterstories by calling for participatory action research and the need to respect the indigenous culture.

Parsons (2008) perhaps spends the most time drawing from CRT in her work. *Positionality of African Americans and a Theoretical Accommodation of It: Rethinking Science Education Research* cited the work of critical race theorists to recognize the role race plays in society and to set up her work around positionality. Parsons, Tran, & Gomillion (2008) goes a step further in another article, *An Investigation of Student Roles within Small, Racially Mixed Science Groups: A racial perspective,* describing how Carla, an African-American student, experiences the inequities that critical race theorists argue exist in society during group

classroom work. The research article described the ways student-to-student interactions marginalized African-American students in their groups that included European-American students (Parsons, Tran, & Gomillion, 2008). The study reported on four different groups of students and how they interact with regard to whiteness. In one group, whiteness was used as privilege as one European-American student takes the lead role marginalizing group members of color. Within two groups, Parsons, Tran, & Gomillion (2008) described whiteness as brokering meaning that European-American students in effect relinquished their white privilege to allow African-American students to take a leadership role in the group activity. In the fourth group, whiteness is negated when the African-American students outnumber the European-American students (Parsons, Tran, & Gomillion, 2008).

Yerrick & Johnson (2011) identify CRT as one of the guiding theories for their self-study of their teaching practices with youth of color. The primary author indicates that the work was based off of his year as the teacher in an Earth Science classroom in which he set out to understand the teacher knowledge needed to teach youth of color. The article was published in a forum format with two responses to the work. Parsons (2011) suggests that racism was not deconstructed as CRT aims to do while Bettez et. al. (2011) asks whether race was fully taken up by the authors. Yerrick & Johnson (2011) are more explicit in naming CRT in their work but as noted in the critiques, CRT is complex and requires a strong link to race and racism.

Table 2.1
Science Education Research Articles Influenced by CRT

Article	Main focus	Influence of CRT	Approach to CRT
Tate (1999)	• Science as a civil right for students of color. • Need for equitable access to science.	• Students of color are marginalized when they do not receive the same opportunities to learn science as afforded to White students	The language of CRT is not used explicitly but the concepts are embedded including Whiteness as property.
Basu (2007)	• Critical subject matter agency • Youth using physics to transform their lives.	• Recognizes the role of power particularly between those who hold a dominant position over others. • Identifies the structural marginalization of Caribbean Youth. • Presents youth counternarratives of agency and desire for success in science	The language of CRT is not used explicitly but the concepts are embedded including counternarratives to hegemonic views.
Bang & Medin (2010)	• Community-based curriculum that includes Native ways of knowing • Challenging Western notions of science and knowing	• Counternarrative to Western epistemology • Recognizes underrepresentation of minorities in science	The language of CRT is not used explicitly but does promote participatory action research among Natives to develop community-based curriculum as a form of counternarrative.
Parsons (2008)	• Calls for science education research from the positionality of African Americans	• Recognizes the dominant culture in the US • Identifies the oppression of African Americans	The language of CRT is not used explicitly but the concepts are heavily used and embedded including systemic marginalization.

Table 2.1 (cont'd)

Parsons, Tran, & Gomillion (2008)	Examines whiteness in the context of group work among students	• Recognizes whiteness as property and privilege among students Identifies marginalization of youth of color in certain group configurations	The language of CRT is not used explicitly but the concepts are heavily used and embedded including White privilege.
Yerrick & Johnson (2011)	The knowledge needed by a White male teacher in an all Black Earth science classroom	• Introduces CRT as a framework for the article Recognizes inequities in science learning based on race of the students	Despite the effort to explicitly draw from CRT, race is not central to the article. As a result, CRT is not fully realized

CHAPTER 3

METHODOLOGY

In considering the most appropriate methodology for this project, youth participatory action research was the best fit for the way youth knowledge and experiences is used to take action against the forces of oppression that continuously create barriers to STEM opportunities for youth of color. As described by Parker & Stovall (2004), there is a need to not only identity racism where and when it occurs, but to move toward critical race praxis. YPAR engaged youth participants bound by a struggle for equitable opportunities to transform social conditions and in this case enable people to achieve one's science aspirations.

Youth voice is often limited and non-existent in the literature especially around issues of race and racism and science education. Most empirical research is presented from a researcher and research subject perspective where stories are told through the author's research agenda, viewpoints, and subjectivities. While case studies often provide an intimate exploration of a research participant, we only hear the participant's voice for a few supporting quotes. As a result, youth voice is given limited to zero consideration when we attempt to understand the needs and ideas of youth as learners. In order to actively engage youth in real world investigation of race and racism, I will involve the participants in youth participatory action research (YPAR). YPAR offers an opportunity to rethink who can conduct research, how research can be used to change social conditions, and who has a voice in the discourse (Ginwright, 2008).

Rethinking Roles of Research Participants

Education research is often criticized for taking place behind the ivory tower of the academic institution and being disconnected from the real world. Furthermore, university researchers are often engaged in research *on* various populations rather than *with* their

participants. The participants are reduced to subjects in the study with the researcher telling stories about their subjects. Once the research has applied their views and subjectivities upon the data, the story told is no longer the voice of the participants but instead a retelling through the researcher's filters. Thus, YPAR is necessary in order to allow youth to have a stake in research and a voice to convey their stories. YPAR challenges the notions of who can do research by recognizing and asking youth to draw from their own *funds of knowledge* (Moll, Amanti, Neff & Gonzalez, 1992). By engaging youth as researchers, there is also a change in the distribution of power as the university research is no longer the exclusive authority. The youth have ownership and power to make decisions regarding the research process from beginning to end.

In the following paragraphs, I examined methodologies including critical ethnography and participatory action research in order to ground YPAR in established academic research. Critical ethnography and PAR are foundations for the newer YPAR approach used with youth. All three approaches rethink and often transform the role of all participants in research. Furthermore, transformation of oppressive conditions toward social justice is central to these approaches to research.

According to Trueba (1993), ethnography helps contextualize events and challenges the Western ethnocentrism. More specifically, *critical* ethnography recognizes and embraces the political nature of research (Trueba, 1999) and works to develop agency within and advocates for the oppressed (Calabrese Barton, 2001) unlike research that attempts to be objective. For example, Delgado-Gaitin & Trueba (1985) highlight the importance of ethnography as a way to study human interactions in their research on Mexican students and teachers' responses to copying. Cultural values of the Mexican students viewed copying as a collaborative learning process but were interpreted as an act of dishonesty by many teachers.

The *participatory* and *action* component of PAR make the methodology unique from most forms of research (Walter, 2009). Participatory means the researcher is no longer on the outside looking in and observing, but rather actively involved with participants in the creation and gathering of data. In addition to the new role of the researcher, action toward changing oppressive social conditions becomes central in PAR. In using PAR, the researcher then works *with* rather than *on* the participants to expose injustices and takes an activist role to bring positive change. Furthermore, PAR provides the opportunity for those who are marginalized to have voice in matters that effect their lives, to gain confidence to challenge inequities, and draw upon resources (Krimerman, 2001).

YPAR centers youth as researchers and leaders for social justice and transformation of social conditions. The shift away from traditional research that often views participants as subjects and offers little in terms of action and agency for the participants is significant. YPAR is a methodology that is gaining increased attention for the way in which participants are persons that are positioned to challenge the systems of marginalization. The shift in purpose can cause conflict for university researchers who are caught between the pressures of academic responsibilities to publish and social responsibility to the populations they recruit as participants (Cammarota & Fine, 2008). In essence, YPAR asks the academic institution to rethink the outcomes of research. Is a contribution to the knowledge base the primary goal? How important is it to enable participants to engage in liberatory practices that improve living conditions?

I pause here to consider the implications of my position in relation to the methodology and to the youth participants. While YPAR puts power in the hands of the participants, what power do I have over the youth? I am a graduate student at the local university and the youth are high school students. I am an adult male and the participants are less than half my age. In these

sample binaries, society tends to grant power in my favor. As much as I desire to relinquish power, my role and identity are inherently laden with authority and privilege. So, what privileges do I hold and how do I use them in the project? I cannot avoid the power dynamics, but I can acknowledge its presence and work to minimize its effect on and over the participants. Furthermore, I will attempt to consider ways my positioning and privileges can be a resource and/or hindrance as I layout the methodology.

Youth voice is virtually non-existent in the education research literature relative to the collective body of work. That is not to say youth voices have not been included in research as they are frequently found in case studies where several interview quotes are used to validate research claims. YPAR differs in that the voice of youth is more than an assemblage of supporting quotes but rather the result of youth-led investigation in which the story comes from youth narratives. The youth are empowered to make evidence based claims from their research. YPAR also positions youth as those with inside knowledge that an outside researcher may never fully access. Particularly in marginalized communities, youth have a wealth of experience and knowledge unavailable to outside individuals. Instead of dismissing youth as incapable or inexperienced as researchers, we have a golden opportunity to extend an invitation to youth to enrich the literature through their expertise.

As I wrote the last sentence in the previous paragraph, I was confronted with the notion that I am using my power to match youth with a tool that they may choose to use for my self-serving purpose of gaining a dissertation. I argue that the system has normalized subordination of youth (especially youth of color) to the extent youth might not recognize their own power. I do not believe my role is to *give* youth power but rather use my privilege to provide the resources necessary for youth reclaim their power. Despite my privileges, I am Asian and thus also a

marginalized person of color. I have been assigned the racial category by the system of oppression. I do not mean to suggest my experiences as a learner with STEM aspirations during my upbringing or in life are similar or consistent with those of the youth participants. We each have our own experiences with marginalization and were brought together by a shared desire to transform learning opportunities for youth of color. I will add that youth gave me looks of disbelief the first time I told them about the project and suggested that they have the capacity to challenge structures in society. Their response reminded me of the value of building relationships and engaging in conversation prior to convening the project for the purpose of enabling youth to decide whether to join the project. I will describe the conversations below in more detail.

While I intended to introduce YPAR to the youth participants, there was a second goal of this project. My second goal was to document the process of engaging youth in YPAR because of a need in the science education literature. Aside from a few YPAR projects in non-science disciplines [i.e., Duncan-Andrade & Morrell, 2008; Irizarry, 2011a], there are few rich descriptions of how youth come to be researchers and the ways youth-led action can work to transform their future possibilities in STEM fields.

I am uncomfortable to position myself as the researcher after championing my desire to work *with* the youth participants. The two ideas seem to be in conflict, but it is necessary if we want to help educators to imagine the possibilities to work *with* their participants and to rethink the way society views and treats youth. I envisioned my role as dynamic with constant shifting between educator, facilitator, learner, resource, role model, and trustworthy friend. I remained actively involved with the youth to support their efforts as described above. I was also in the unique position of observing what transpired among the youth and through the YPAR process for the goals of the dissertation project. I did not claim objectivity as I have strong and passionate

feelings of care and concern for the youth and toward the research goals. I hoped that the youth and I would have a shared vision in our fight against racism in order to improve opportunities in science for populations of color. I argue that individual subjectivities are assets in this struggle against the forces that conspire to keep people of color from attaining equal opportunities as our White counterparts.

Here again, I must be cautious to not slip into the role of an oppressor. I navigated the system to reach graduate school, and to do so meant I benefited from the very system that marginalizes youth of color. I am well indoctrinated into the meritocratic system that says hard work pays off. But, the system does not work for everyone when extra barriers are placed before subordinate groups. I did not want to reinforce meritocracy but rather sought to use my privilege and experience to help the youth challenge system and the barriers. To simply negotiate around the barriers means they are left standing for the next generation of youth of color when we can eliminate them now.

Humanizing Research

As a researcher, I called upon the work of Paris (2010) to consider how to humanize research with youth participants. To humanize research is to respect participants as more then subjects of a study. Often, research is conducted *on* the subjects of a study rather than *with* the participants. In order to assure that this work was humanizing, it was essential to build relationships with the youth based on trust, caring, and love. I was fortunate to meet or been introduced to the youth I hoped to invite as participants and with whom I wanted to develop stronger relationships. I was at least an acquaintance to many of the youth who recognize my regular presence through my involvement with an informal science program at the youth center. Some of the youth were former participants in the science program while others asked me about

the things we did in the program on green energy technologies. In these exchanges, I mentioned that I was thinking about developing a project with the teenagers at the center to which the youth often expressed both curiosity and interest. With permission from the leaders of the local youth center, I was granted space in the building to set up meetings and invited the youth to join me for informal conversations over food. Over the course of these initial meetings and conversations, detailed below, we started the groundwork for a YPAR project.

As described in the introduction, I already had a pre-existing relationship with Malcolm through his work as a teen leader during a summer with the informal science learning program. I learned more about Malcolm through regular interactions in the context of his role as youth leader and my role as one of the co-leaders of the project. Malcolm would ask about what I do as a graduate student. In response, I shared what I do as a researcher and some of the issues I think about working with the youth program and in my own research interests. Malcolm introduced me to his brother, Caesar. Malcolm invited Caesar to join us for the conversation sessions.

The teen program director at the center introduced me to Justice and Deelilah. I was previously acquainted with Justice through her role as a junior staff member at the youth center. The teen director felt the female participants could gain important skills and knowledge to help them reach their college aspirations if they were to join my project as youth researchers and endorsed my proposed project. It was very important to me that the youth were not coerced or unwillingly placed in the research study. I briefly described for Justice and Deelilah my ideas for creating a program for teens and invited them to join the conversation group leaving it very clear that the choice is their own whether to join the conversation.

I realized the potential for a disingenuous relationship despite my attempts at humanizing research. While I already had an in at the space where the potential participants spend a lot of

time outside of school, I did enter with goals including working with the youth to gain a dissertation project. While the dissertation was a requirement the graduate program, my passion was to work *with* the youth to transform science learning experiences and create a space for youth to develop the necessary skills to challenge social inequities they encountered now and in the future. This project was foregrounded in the youth and the willingness and desire of the youth to participate in this joint endeavor. Part of the relationship building required honesty about the benefits I stood to gain but also being sincere to the mission of working with youth to transform social conditions particularly those that marginalize the youth as science learners. I wanted to build a relationship that extended beyond just the project in ways that allowed us to support each other through care and respect for one another as fully realized human beings.

By initiating a space to talk and get to know each other, I hoped to build new relationships and strengthen existing ones. And, by gradually developing a space to talk about youth experiences as a science learner and inviting their stories, I hoped that they might take interest in digging deeper into the issues. To various degrees, all of the youth except Malcolm had mentioned a general disdain for science while also expressing interest in STEM fields. They expressed how they have felt that science is, as described by Emdin (2009), an alienating space. The youth recognized that science as they experienced in school to be problematic despite their desires to be engineers, medical professionals, and veterinarians.

Critiques of YPAR

One of the primary critiques of YPAR is that it is not an academically rigorous research methodology (Cammarota & Fine, 2008). Cammarota & Fine (2008) counter the criticism and argue that participants are in fact engaged in "critical scientific inquiry" that challenges institutions of power and fights for social change. Ginwright (2008) adds that YPAR allows us to

"move beyond the rather static and restrictive notions of methodology to broader and richer understanding of how our bold imaginations, dreams, and vision can lead us to revolutionary forms of participatory action research" (p. 21).

In response, I argue that the mere suggestion that youth are incapable of rigorous research only reifies the dominant notion of a deficit model. Predisposing youth as less than able without justification other than their age and inexperience and discrediting their knowledge and experiences is in itself a form of oppression. The deficit model approach maintains the hegemony that continues to suppress opportunities especially for youth of color and allows those with power to control what counts as knowledge. Rather than capitalizing on knowledge, skills, and interests of youth, the deficit model renders youth powerless and incapable of accomplishing great things. YPAR is in fact an empowering pedagogy that develops critical skills and challenges not only what we consider youth capable of doing but also the very structures that try to marginalize young people based on social markers of age and race.

Pre-dissertation Groundwork

In preparing to initiate the project and the data collection to follow, I started meeting with the youth once a week for conversation sessions at the youth center. The purpose of inviting the youth to join me in voluntary conversation prior to the start of the project served three purposes: (1) building relationships; (2) presenting the nature of the project including what roles youth might take up; (3) and engaging in conversations around youth experiences including with race and racism. Thus, I was able to provide youth with a better understanding of the project and my intentions by inviting them to participate while cultivating a relationship. Additionally, I wanted the youth to make an informed decision on whether to join and have ample opportunities to ask me questions.

Building relationships was an important feature of YPAR. For example, race and racism are already difficult subjects to have conversations about and are often avoided especially across people of different races. Developing a relationship based on care and trust enabled us to begin a dialogue and identify common and individual goals for the project. As the academic researcher, I wanted to be transparent with the youth about what I stood to gain, what they stood to gain, and what were the possible outcomes including shortcomings for either of us. It was also necessary to recognize YPAR is difficult work and that we will needed to support each other.

I felt strongly that participants needed to have adequate time to understand the project and what their participation asked of them especially for a long-term investigation. Sustained conversations over several weeks afforded me the opportunity to present topics for conversation that helped the youth to understand the proposed project and to begin envisioning their roles and make an informed, voluntary decision to participate.

Finally, the conversations were a place to start exploring personal experiences of the youth and even share my own stories with the group as we all tried to better understand how race and racism impacted our lives. By having such conversations, we set a tone for openly discussing complex issues in a safe space and minimized potential apprehension moving forward. At the same time, uncovering some of the stories of the youth helped shape possible directions for YPAR. As a facilitator for the project, I kept in mind my obligation to suggest parameters that might be useful for the youth to both have a starting point for investigations and managing the size of the endeavor.

Weekly Conversation Groups

Given that YPAR is youth driven, I was sensitive to the authority I could exert during the work both intentionally and unintentionally as a facilitator. The youth expressed that they had

very little, if any, experience with social science research and thus I needed to be more prominent at times as a participant scaffolding and facilitating the sessions. My long-term goal was to fade back so that youth were empowered to use the research skills needed to identify new research agendas and conduct their own investigations. I initially identified specific activities to support the development of a research mindset and the tools that youth may need to take on a researcher role. As previously described, I met several times with the youth to have conversations that set up and facilitated their entry into YPAR. In these sessions, we: (1) explored ideas of race and racism, power, privilege and justice; (2) shared experiences in school and science learning; (3) discussed popular media and news media including the shooting of a young, Black male, Trayvon Martin; (4) examined other YPAR projects and youth generated products; and (5) started a dialogue about what is research and how can research be used to effect social change.

We started by deconstructing race. We watched a video of teenage students who were conducting laboratory tests to see if there was a way to genetically differentiate between races. The video showed there is no biological merit in distinguishing people by race. We then worked to identify examples of racism. It was especially challenging to identify racism if it had become normalized into the daily experiences of the youth. Identifying racism helped to raise critical consciousness in order to acknowledge that racism exists and serves to marginalize people of color. In our pre-dissertation conversations, I introduced a series of scenarios including those based on current events in the news media and asked the youth whether these incidents were examples of racism. For example, racial profiling was a hot topic due to various state legislatures moving to pass laws allowing law enforcement to stop people based on appearance and request legal citizenship documents. When presented with the real scenario, the youth concluded racial

profiling is racist and that it was wrong to stop someone simply because of the way they look. They were not only speaking to the scenario but to their own experiences having received looks of suspicion from people in power whether at school, the mall, or other spaces.

On another day, we had conversations on power, privilege and justice. I asked the youth to first share their ideas and definitions of power in a social context. For the youth, power meant having control over someone else. We mapped out a power hierarchy for their school and they typically placed themselves at the bottom behind teachers and administrators. According to the youth, the only other people that might have less power than the youth are the school janitors. Privilege was harder to define but they quickly recognized that there are certain advantages people have over others. The youth equated justice to different ideas including revenge and fairness. Revenge as justice was understood in the context of a transgression done unto others is met by a similar act done unto the perpetrator or as some may say, "an eye for an eye". We pushed to think about justice in other ways that led the youth to suggest that "fairness" was an integral part of justice. As the conversation progressed, fair meant that all people were treated the same and had the same resources and opportunities.

In the next conversation following up on fairness, Malcolm suggested that students regardless of color and the school they attend had equal opportunities for success. That is, fairness prevails in the school experiences of youth across the country. Knowing Malcolm's story shared at the beginning of this paper, I pushed on his suggestion with all of the youth. When I asked about reports of school performance that characterize their high school as underperforming, Justice suggested that while she wants to work hard and succeed, it was the other kids around her that didn't care about learning and brought down everyone around them. Malcolm reiterated that success was determined by how hard a person is willing to work. The

youth centered responsibility on the individual and essentially absolved the school or any social structures from having a role in the success of students.

In the next session, I invited the youth to revisit the idea of self-efficacy they espoused and to consider if schools were different in any way. I asked how many science classes their school, a majority minority building, offered to which I got various responses. Then, asked the same question for a majority White school in a nearby suburb to which the group answered that they also offered a similar number of science classes. In an effort to confirm their suggestion, the youth went online and located curriculum guides for both schools. To their surprise, they found the suburban school had several additional science courses available. And even more surprising was the way the two schools addressed career and technical programs. Their urban school indicated entry into the career and technical program was highly competitive and reserved for the best students and went on to include several pages listing details and courses offered. In the guide for the suburban school, only one page was dedicated to career and technical opportunities to which an interested student should speak to their guidance counselor. Furthermore, the description did not build up the career and technical program as prestigious but stated much more flatly that the programs prepared students for an immediate career after high school. It was in this moment that the group began to wonder about other ways that the school and their school experience might be different from students at other locations.

The examination of curriculum guides opened up the opportunity for me to ask the youth more about their experiences in science. We talked about what a typical day looks like in science. The youth complained about how little the teachers teach or try to help students. Their days in science are filled with note taking and completing busy work. Laboratory experiments were either rare or non-existent across their experiences. In these conversations, I learned that

Malcolm and Caesar were interested in engineering and Justice wanted a career in the medical profession. Deelilah was less certain about her future goals being that she was only in the 8th grade.

In order to consider how racism appears in other places besides school, we also talked about popular media such as movies. In particular, we looked at movie trailers for *The Blindside, The Help* and *Precious*. Most of the participants had watched the full movies previously for their own entertainment. The youth reported enjoying the movies when they watched them the first time, especially *The Blindside*, based on a true story where an affluent White family takes in a troubled Black high school student who becomes a successful football player. Given our prior conversations the youth began to critically examine the movies and the portrayal of Black people being "saved" by Whites and the representations as thugs, unintelligent, and dangerous. The conversation broadened the understanding of racism as a systemic issue.

During the conversation groups, the story of Trayvon Martin, a Black teenager shot and killed in Florida by a neighborhood watch leader, George Zimmerman, because he looked suspicious walking through a gated neighborhood became one of our topics. The incident sparked outrage across the country for the racist overtones given that the shooter profiled and confronted the unarmed victim leading to the murder. The youth were clearly following the news based on ways they were talking about the senselessness of Trayvon's death.

Throughout the conversations, I sensed the youth were aware of the ways that they too were subjected to oppressive conditions but did not necessarily see the possibilities to take action from their assumed subordinate position. In order to imagine possibilities, I shared a book with youth co-authored chapters from a YPAR project in an East Coast high school (Irizarry, 2011b). We also watched videos of protests by students in the Tucson Unified School District following

the controversial decision to eliminate all ethnic studies programs on the unfound claim teachers were using these spaces to create resentment against Whites. While the book and videos helped the group see that youth can have voice and power, I detected a lingering sense of helplessness. I wanted to make sure what I interpreted as helplessness didn't come from a feeling that I was asking the group to put themselves in situations where they could encounter a negative backlash. In fact, the youth wanted to fight the inequities that confronted them daily. Justice was especially outspoken expressing how mad it made her but how she wanted to "do something".

In the last set of conversations leading up to the project, we started to talk about research. We started to explore several questions. What is research? What counts as research? What are the different sources and types of data? What kind of data is necessary? How can data be collected? How can data be used as evidence to support an argument? Given that we had reached a point where we started asking questions about research, I invited the youth to join the project and have the opportunity to explore these questions through YPAR. Table 3.1 summarizes the conversations that led up to the start of the project.

Table 3.1
Summary of Pre-dissertation Conversation Sessions

Conversation Topics	Summary
1. Race as a social construct	• Debunked the notion race is biologically supported genetics.
2. Identifying racism	• Youth shared some of their own experiences with race/racism and began to interrogate other examples.
3. Recognizing power	• Youth developed a hierarchy of power within a school and identified the place of students at the bottom of the order.
4. Privilege, justice, and fairness	• The group explored examples of privilege to develop an understanding of how it works for those who have it. • The youth offered their ideas of justice and as a group considered what it meant in regards to racism. • The group discussed and confronted grand narratives of all students having an equal opportunity to succeed with hard work.
5. Comparing course offerings	• Youth examined the curriculum guide for their school and compared it to a nearby suburban majority White school • Youth discovered inequities in the number of science courses offered and the over-glorification of vocational opportunities at their school.
6. Race in popular media	• Youth explored recent movies and the portrayal of people of color. • Blacks are often "saved" by Whites from their marginalized positions. • Blacks are often portrayed as less intelligent, dangerous and/or poor.
7. Racism and the murder of Trayvon	• The youth responded to the unfortunate death of Trayvon Martin. • Recognized how racism persists in society.
8. Examples of YPAR	• The group explored the youth co-authored chapters in Irizarry (2011b) • Youth watched videos from the Tucson student walkout in response to the termination of ethnic studies.

Data Collection and Data Sources

Data collection included audio recordings and field notes for weekly group meetings with the youth. In the summer while the youth were out of school, we held five extended session on the campus of the nearby university. The purpose of the extended sessions was to set aside a time for continuous work at a critical point in the YPAR cycle between research and action. During the sessions, the youth developed research instruments, analyzed data, and generated plans for action. The artifacts included the creation of the survey instrument and video public service announcement. In the fall, we resumed weekly meetings at the youth center.

There were two ways that I was involved in the project. First, I facilitated the YPAR component including engaging the youth in sessions where we considered various issues of around race and racism, learned to do research, analyzed data, communicated what we learned, and planned to take action based on the results of the research. Second, as a researcher, I also gathered data to explore how youth engage in YPAR. I will address the two components separately in the following sections.

Engaging in YPAR

In the following section, I turn attention to the ways YPAR was enacted. I tried to remain in the shadows only coming forward to scaffold youth experiences with research as necessary. The youth worked collaboratively to identify their research questions and research strategies to find answers. On occasion, I built on ideas brought up during the initial conversations to provide support for doing research. I will describe the YPAR activities within the four major components of YPAR including: (1) investigation; (2) planning; (3) action; and (4) reflection.

Investigation. The first task was to identify a problem for inquiry. Malcolm's assertion that schools were equal and that self-efficacy determines individual success provided the starting

question for the YPAR investigations. The second question came from youth narratives that suggested they were interested in STEM related careers but also had negative experiences with school science. In order to complete the investigation, the youth considered research instruments to answer these two questions. Thus, YPAR demanded that youth become skilled researchers in order to gather data to answer their questions and support their claims. The youth considered different research instruments for data collection. For example, we selected interviews as one tool for gathering data. The youth decided to ask college students who presumably arrived at the local university after graduating from high schools across the state about their science experiences both prior to and in college to see if they were supported at both locations to be successful in STEM areas. The youth worked on their ability to write questions and conduct interviews that would generate useful responses. As a group, we explored a full set of research tools that included examining school documents, comparing school data, designing and conducting surveys, and gathering data through observation.

Planning. Planning is the second component of YPAR. Planning bridges the research with the process of devising calculated tactics to challenge power structures that create conditions of oppression. We brainstormed strategies for taking action so that we could plan accordingly. For example, the youth suggested social media such as Facebook as a space for the group to report their findings and raise awareness to the ways students are marginalized. The other strategies included producing public service announcements to be shared through social media and other outlets. The youth also included taking their research to the school board to voice their concerns. As the project developed, the youth added ideas for taking action. The youth had not originally considered conference presentations as a way to plan for action until and opportunity presented itself.

Action. Action was tied to planning. In taking action, the youth implemented their plans. The youth created a social media presence setting up a Facebook page and Twitter account. The youth wrote scripts and generated video and radio public service announcements. The youth prepared conference proposals and presentations. In perhaps the largest action undertaking, the youth designed a food and nutrition teaching unit. The teaching unit was implemented with their younger peers at the youth center. The youth participants were purpose to target specific audiences to whom might they deliver their message if they want to truly affect change. They debated the merits of going to school administrators or the school board should they find evidence that there are structures in school that unfairly limit possibilities for students to succeed.

Reflection. That final step of YPAR is reflection. Taking a moment to look back across the project will helped us evaluate the success and impact of our actions. We asked whether we were able to effect change. It is important to note that change can appear in many different ways. Some change might be subtler raising awareness and creating a space to be heard to a more explicit result that leads to structural change to reduce and eliminate marginalization. We evaluated the outcomes knowing that we will be engaged in what is a long-term struggle against racism and oppression.

Understanding Youth Experiences and Participation

Along with the careful planning and consideration for how I can engage with, support, facilitate, and learn from YPAR with the group, I conducted my data collection to understand youth participation throughout the project. Specifically, I was interested to know whether enacting YPAR leads to transformation among the youth as capable change agents from their initial self-described stance as powerless. I describe the data I collected while working with the youth. I also drew upon archival data from the pre-dissertation sessions that included field notes,

recorded conversations, and youth created documents on the power hierarchy in school. The dissertation data collection included observation and field notes, audio and video recorded group sessions, individual interviews, youth produced artifacts, and conference proposal and recording of presentations.

Observation and field notes. In most cases, I was a participant observer. I was constantly observing the ways YPAR is enacted by the youth whenever we convened but also found myself engaged in YPAR. Observations were recorded in my field notes to document the chronological and key events that transpired during various sessions with the youth. Field notes helped capturing researcher insights and reactions immediately after each session. Additionally, observations of the youth interactions provided insight to the way identity and knowledge influence how youth collaborate and contribute in a group YPAR project. Field notes documented various aspects of the sessions including new ideas that get introduced, potential problems that we encountered, and possible other ways our research and action might shift. Field notes were kept for the weekly sessions.

Recorded group sessions. I audio recorded sessions and saved them as digital files. Audio recordings allowed verbatim capture of conversations that transpired within the sessions. Transcripts were created for the sessions. Video recordings of session proved to be too distracting for the youth as their attention was often drawn to the camera. Therefore, audio recording became the primary format for capturing the sessions.

Conference presentations. I captured video recordings of the conference presentations and saved them as digital files. Video added a visual element in the event it is useful to analyze what audio or field notes cannot show. For example, if a participant points to an object in the room, makes certain gestures, or has a particular emotional response those moments may not be

captured if only audio is used and verbal recognition of those things is not made. For conference presentations, I saved the original proposals and presentation scripts authored by the youth as data.

Interviews. I interviewed each participant twice during the project and audio or video recorded our conversations as digital files. The first interview was around their personal histories. The second interview was on their science experiences and aspirations. Each interview lasted less than one hour each. I transcribed the interviews as document files.

Youth-produced artifacts. Through YPAR, youth created various artifacts and are included under this umbrella category. The youth-produced artifacts include documents created electronically on laptops used for the project, videos and slides used in presentations, public service announcements, teaching materials for the food and nutrition unit, data collection instruments and accompanying data, and letter to the school board. This category also includes my correspondence with youth namely through text messaging.

Methods for Data Analysis

Qualitative approaches were used to analyze the data gathered. The data was used to develop youth narratives about their experiences with school science that the barriers they encountered along the STEM pathway. The coding scheme was guided by tenets of CRT as described in the conceptual framework. The data was coded for: (1) instances where youth explicitly name racism; (2) ways privilege (and deprivileging) appear in youth experiences; (3) the counternarratives of the youth that challenge hegemonic views that negatively portray learners of color; (4) instances where interest convergence occurs; (5) examples of youth describing or actively working for social justice; (6) ways colorblindness is used against the youth; and (7) specific examples of racial microaggressions encountered by youth. I also coded

instances where youth did not explicitly name racism even though they are being subordinated by the action of others in their retelling.

The data analysis of youth participation in YPAR focused on youth agency as exhibited throughout the project. I coded youth dialogue, actions and participation in events and mapped them over the length of the project. Agency is also useful to consider because the goal of engaging in YPAR is to create space for transformative personal growth as well as taking action. Youth voice and empowerment are manifestations of agency. Therefore, coding for agency can provide a clearer picture of the way youth take on YPAR as a tool to remove the obstacles place in the STEM pathway of marginalized students.

The coded data, youth narratives, and transformations in agency will be used to construct a critical ethnography of their experiences along the STEM pathway. Other data will be used to supplement the ethnographies of the youth. The youth will be invited to help edit and revise in order for the narratives to be the best representations of themselves.

At the conclusion of data analysis, the goal is for us to provide a rich account of changes in agency across the experiences in YPAR and the ways we have transformed the STEM trajectory for ourselves and students of color like us with similar aspirations.

Table 3.2 shows the research questions and summarizes the types of data collected. Table 3.3 provides a timeline for the project including my researcher roles and an outline for the YPAR component goals.

Table 3.2
Research Questions and Types of Data

Research Questions	Types of Data
1. How do youth of color talk about their experience with school science?	• Archival data • Observation and field notes • Recorded group sessions • Interviews • Youth produced artifacts
2. How does racism in high school affect STEM trajectories?	• School documents • Observation and field notes (including engagement with research, planning, action and reflection) • Recorded group sessions • Interviews • Youth produced artifacts
3. How do youth engage youth participatory action research to navigate barriers to STEM trajectories?	• Archival data • Observation and field notes (including engagement with research, planning, action and reflection) • Recorded group sessions • Interviews • Youth produced artifacts

Table 3.3
Timeline for the YPAR Project

Date	Major goals
Prior to May 2012	Researcher goals: • Begin initial conversation sessions. • Group conversations around race, racism, power, social justice, and science experiences of youth.
May 2012	Researcher goals: • Continue conversations around race, racism, power, social justice, and science experiences of youth. • Introduce the group to examples of youth led research and social change initiatives. • Facilitating becoming researchers: positioning youth to be researchers. What does it mean to be a researcher? What are the roles and responsibilities of researchers? • Conduct individual youth interviews. Possible youth goals: (RESEARCH) • Identify goals of YPAR research. What do the youth want to investigate and why? What action/response is appropriate based on findings of the investigation? What data needs to be collected? What are the best methods for collecting data? • Identify research resources, participants, and locations. • Develop research data collection tools and instruments (i.e., draft interview questions, create surveys, etc.) • Recruit participants and arrange for data collection.

Table 3.3 (cont'd)

Date	Major goals
June 2012 – August 2012	Researcher goals: • Provide continuing support for youth including with data analysis. • Conduct individual youth interviews. • Document youth participation. • Analysis of researcher gathered data (interviews, group conversations, etc.). • Assist with concluding research and starting planning. • Lead intensive workshops during two-week summer session developing various skills (i.e., writing workshops, digital media workshops, public presentation skills). Possible youth goals: (RESEARCH) • Continue data collection. • Identify missing data and plan how to collect data. • Finish data collection and prepare data for systematic analysis. Practice coding and reliability. • Begin analyzing data. • Develop a timeline for products of analysis (i.e., written papers, multimodal digital artifacts, etc.) (PLANNING) • Design survey instrument. • Identify audience(s) and the best way to deliver their messages. • Create social media websites. • Author public service announcements.
September – October 2012	Researcher goals: • Continue supporting youth research practices. • Continue gathering data on youth participation including audio or video recordings of sessions. • Conduct individual youth interviews. • Document youth participation. • Continue analyzing data. Possible youth goals: (ACTION)* • Administer survey of high school students. • Disseminate public service announcements • *Action to be taken will largely be determined by the planning phase.

Table 3.3 (cont'd)

Date	Major goals
November 2012 – May 2013	Researcher goals: • Conduct individual youth interviews. • Finish analysis of researcher data. • Complete proposals for conferences. • Write the dissertation. Possible youth goals: (ACTION) • Teach food and nutrition unit • Conduct workshop for peers at student leadership conference. • Virtually present at academic research conferences. (REFLECTION) • Evaluate the outcomes of YPAR.

Ethical Considerations

The safety and well-being of all participants was prioritized throughout the study including acquiring the approval of the Michigan State University Institutional Review Board for Research with Human Subjects (Approval #x12-207e). All participants provided consent including parental consent in the event they are under the age of eighteen. Participants were informed of their right to end their participation at any time.

As a researcher, I considered the challenge of using race and racism as contentious topics for youth to engage. The introduction to race and racism during the initial conversations helped facilitate open discussion and a safe space to discuss oppression. The emphasis was placed on proactive measures to improve social conditions and fight racism.

Limitations

I am aware of the potential limitations of my own racial/ethnic background when working with youth of color from other backgrounds. Categorically, I am considered Asian-American/Pacific Islander (AAPI). The youth participants are all African-American. As we are all considered racial minorities in the US when compared to the majority White population, we

have certain shared experiences with marginalization. Yet, this is where I must be hyper aware of where the overlap ends and where each individual brings their own experiences with oppression.

In a personal communication with Charles Lawrence, regarded as one of the founding scholars of CRT, he reminded me that the fact I am taking into account my racialized identity in relation to the youth is important and enough to move forward with the work. We, as people of color, are in this struggle collectively so we must all work to fight the system of marginalization. Taking his charge to heart, I am in a role to work with the youth for positive change and will look to be guided by humanization to insure that the project is being carried out for the right reasons.

I considered myself a partner to the youth of this study in the fight against racism. As a partner, I aimed to work alongside youth to fight systemic oppression of all people of color. I was a facilitator of YPAR supporting youth researchers in their work by engaging them to consider different ideas and perspectives to inform their process. I also accessed material support and provided access to technology to be used in the research process and communication of findings from the YPAR project.

CHAPTER 4

YOUTH PORTRAITS AND SCIENCE NARRATIVES

This chapter establishes the background stories of the youth participants that joined this study including their STEM aspirations and experiences in science learning. The following chapter is organized into participant portraits that provide a brief introduction to the youth including who they are in their daily lives and how they described their experiences with science. I purposefully use the term portraits in that the descriptions offer only a brief snapshot of who these youth are and what they value and do not fully encompass their rich life histories and experiences. In order to humanize the participant experience, the portraits are essential to help present the youth as individuals with unique interests, concerns, and aspirations.

After the participant portraits, this chapter identifies the intersections across science narratives told by each of the youth. While each youth presented a different science narrative tied to their experiences, common themes emerged that presented the foundation for engagement in YPAR as a group. As I will show later in Chapter 5, the science narratives layered with YPAR findings demonstrate that youth of color are not well supported to pursue their STEM aspirations. The youth draw from their science narratives and research to plan action toward transforming science learning for more equitable science learning opportunities. Then as I demonstrate in Chapter 6, one of the ways in which the youth take action is through teaching their peers a science unit using teaching practices that were seldom used in their school science experiences.

Introducing the Youth Participants

The youth participants are all members of a local youth center that provides programming after school and during the summer. After I received the support of the youth center, the youth were invited to join the project. The decision to participate was completely voluntary. I first

invited Malcolm to come to the initial gathering and learn more about the opportunities of the project. As mentioned, I knew Malcolm from his prior involvement in a different project where we first met. I encouraged him to bring friends who might be interested as well. I asked the director of teen programming if she knew any youth who might be interested in the project. She was highly supportive of the project and believed the project could have a positive impact on the youths' college aspirations. Thus, the teen director encouraged Justice, Caesar and Deelilah to talk with me. The teen director also introduced Lil c to me, and she joined the project a few months after we had started meeting regularly. Over the course of the year, other peers have been invited by the youth and have stopped in. For many youth, they could not attend the youth center or our meetings regularly because of other extracurricular activities or commitments. Thus, while project membership sometimes changed, the core members were Malcolm, Justice, Deelilah and Lil c. Caesar did stay with us for much of the duration of the project but became less involved due to joining school sports teams. All five participants included in this investigation are African American. The youth can be seen in Figure 4.1. Table 4.1 provides a brief overview of youth science narratives.

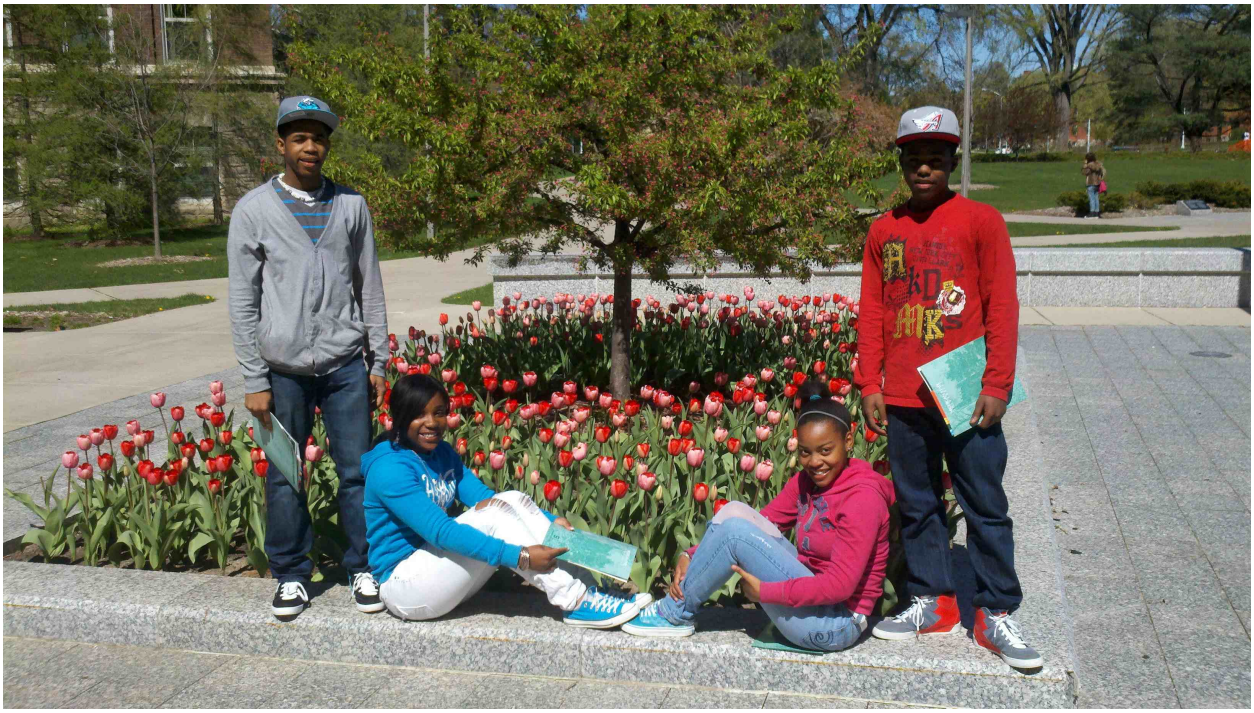

Figure 4.1. Photograph: projectERASE members visiting the campus of Michigan State University. (l to r) Malcolm, Justice, Deelilah and Caesar. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

Table 4.1
Youth Participants of projectERASE

Pseudonym	Malcolm	Justice	Lil c	Deelilah	Caesar
Gender	Male	Female	Female	Female	Male
Grade	College Freshman	11th grade	11th grade	9th grade	10th grade
School	Community college/Murphy HS grad	Murphy HS	Murphy HS	Murphy HS	Murphy HS
Aspiration	Kinesiology major	Pediatrician	Forensic scientist	Law enforcement	Engineer
School science experience	(In high school) Frequent note-taking, no labs in physics	Busywork, little assistance from the teacher	Overcrowded classroom of 46 in chemistry	Negative perception from the teacher due to older brother's reputation	Boring with lots of busywork.
Memorable science experience	Informal science program at youth center	Making a solar system model	Conducting an acids and bases lab in chemistry	Pond water investigation	Informal science program at youth center

Portrait of Malcolm

Malcolm is an African American male high school graduate. Malcolm first joined my project when he was 17 and in the twelfth grade. Today, he is taking classes at the local community college with plans to complete a two-year program in kinesiology. Then, he plans to transfer to a four-year institution to receive a bachelor's degree. In addition to being a student, Malcolm works at the local youth center and oversees the gymnasium. Malcolm is in charge of the programming of fitness games and activities and coordinates intramural programs for the youth members. Malcolm also coaches the youth basketball team for the youth center running practices twice a week with games on Saturdays.

Malcolm was born and raised in Great Lakes City and is the middle child among five children in his family. The eldest sister lives outside the household but the other four live with their father in a modest home within a couple miles of the youth center. Malcolm and his father are full-time staff members at the youth center. Malcolm, his father and his younger siblings are usually at the youth center after school throughout the week. Caesar is the younger brother to Malcolm and a participant in this project. Caesar's portrait follows later in this section.

The youth center has played a central role in Malcolm's life. The center focuses on providing youth with a safe place outside of school hours to engage in various programs that provide academic support, leadership opportunities and extracurricular enrichment. I regularly saw Malcolm around the youth center but at this point hadn't formally met. During my visits to the youth center, I noticed Malcolm assisting adult staff during snack time and helping with other tasks. I learned that as a high school student, Malcolm and other youth served as junior staff

members picking up a few hours each day and earning a paycheck. Teen members who exhibit leadership skills, responsibility and maturity are selected to be junior staff.

I first met Malcolm well before the start of this investigation. I was a regular presence at the club as an adult leader for an informal science program offered to middle grades youth. Malcolm was a former participant in the science program prior to my involvement. Malcolm, as a former participant, was invited to serve as a teen leader for a two week summer session of the program before his senior year of high school. Alongside the other adult leaders of the informal science program, Malcolm worked with us to both lead and teach portions of the summer session. Our summer session was focused on energy efficient building design. The culminating task asked the youth to propose a design for a new teen space at the youth center that included green design principles. In order to build the design, one of Malcolm's major contributions was to create a digital template of the space using Google Sketchup software that would be provided to all of the youth. Sketchup is a 3-D design tool used to create various graphical representations of objects including buildings. He presented the template before the group and demonstrated various tools for using Sketchup. As the youth started working with the template by adding their design features, Malcolm moved between the groups offering assistance as needed. In this space, Malcolm was a leader, technical expert and valued contributor to the informal science program.

It was during the two-weeks I had a chance to begin to know Malcolm as we frequently spoke about both matters related to the summer science program and his interests in life. I learned that Malcolm loves sports, and basketball is Malcolm's passion. So, it was no surprise that after high school, he took over the duties of running the gym at the youth center. Malcolm would spend all his time in the gym if he could. He loved to play basketball with the younger kids at the center. I often dropped by the gym to say hello and watched as Malcolm gave tips and

pointers to the youngsters learning the game or counseled the occasional youngster that became upset during play. Malcolm demonstrated compassion, maturity and responsibility as a role model for the youth at the center. Outside of the youth center, Malcolm was a percussionist in the school band. He was active with the youth group at his church. Based on my observations and conversations, Malcolm was a youth leader with diverse interests and involvement.

I discovered that his STEM aspirations at the time included becoming an engineer as described below. Excited to hear he had STEM related aspirations, I asked him what sorts of things he was doing to prepare to go to college for an engineering program and which colleges he was considering attending. Instead, I found out he was not receiving the support needed to navigate the road to college. Malcolm had not received the support he should have had much earlier in high school to know the many things he needed to do prior to his senior year to apply for college. Malcolm's cumulative grade point average was below the average among students accepted to a four-year college. Malcolm had not attempted the college entrance exams. He did not know when or how to apply for admission to colleges or how he would pay for college. In these conversations over two-weeks, I found out more about the ways Malcolm was both behind in the process of applying to college and largely under-supported by his school.

The conversations pushed me to ask how and why Malcolm, despite his success in different spaces including the youth center and the summer science program, was woefully behind and unsupported to follow his college aspirations. The more I engaged Malcolm in conversations around his engineering trajectory, the more I learned about how he was not being prepared to meet his goals.

Malcolm's Science Narrative

When I first met Malcolm he was interested in becoming an engineer. He described how his experiences as a participant in the informal learning program provided the motivation to pursue engineering. He wrote in a letter:

> I joined GET City in 2007 [as an 8th grader] and have stayed in it ever since. Last year I was a GET City Instructor. GET City actually helped me in most of my school classes, like physics and math. Most of the stuff in those classes, I already knew because of GET City. I did not have to ask that many questions in class. I got on pretty quick because of what I learned in GET City. Before I was in GET City, I did not know anything about engineering, but the program taught me a lot more. I am interested in engineering for my future. GET City helped me think more about engineering, so I know what to expect when I get to that point. I'm applying for college at State University and at Local Community College to study engineering.

As Malcolm's writing suggests, he was interested in engineering, and recognized that developing knowledge and skills in science and mathematics are critical to this kind of future.

However, Malcolm was uncertain about what an engineer does, or how to pursue his goal. He stated that he wanted to do more research on engineering, "[I] actually haven't done much research. I want to do more research about it. Actually popped up in my head a few years back. I think it's fascinating to do that kind of stuff. Any engineering I'd take" (Malcolm, Interview, 2012). He also knew that this career track would require him to work hard. "I wouldn't know what it would be like, it would be a big task, you'd have to be on it, you can't be lazy" (Malcolm, Interview, 2012).

After graduating from high school, Malcolm investigated the programs of study at the local community college that offered the option to obtain an associates degree and transfer to a

four year college to complete a bachelor's degree. He switched to kinesiology when he allowed his interests to help identify careers that would provide personal satisfaction. As mentioned above, basketball was a big part of Malcolm's life. Malcolm loved to play, coach and watch basketball. Kinesiology allowed him to pursue a career without having to abandon his love for basketball. For Malcolm, kinesiology is a pathway to pursue both his interest in science and sports as he dreams of becoming a prominent basketball coach at the highest levels of competition. He spoke with excitement about the possibility of completing a two-year associates degree and transferring to a nearby four-year university with a highly regarded men's basketball team. Malcolm hopes to work with the basketball team as a student assistant while studying toward a kinesiology degree. He is also holding onto a dream of making the team as a walk-on.

I wanted to know more about Malcolm's interest in STEM fields so I asked about his best science experience. He recalled his participation in an informal science program he wrote about above, GET City. Malcolm valued the opportunities provided by GET City to actually do science and go on field trips. He added that the informal science program "looked at things more into details, not just the basic stuff". From my knowledge and role as adult leader of GET City, youth engaged in authentic investigations of energy related issues in the community, communicated their findings using digital media, and presented in various community spaces. The act of doing science is what resonated with Malcolm in his experience with GET City.

I asked whether he had any memorable experiences with school science, and Malcolm described the time his science teacher intentionally set his hand on fire (Malcolm, Field notes, 2013). The teacher was sharing a demonstration. I asked what the science concept was behind his teacher's fiery demonstration to which Malcolm thought that it had to do with testing different

liquids. Although Malcolm did not fully recall the purpose of the demonstration, the visual of seeing his teacher's hand covered in flames left a lasting impression.

I continued to ask Malcolm questions about his interest and experiences in science in conversation and after he joined this project during interviews and group meetings. Malcolm generally had a favorable view towards school, and in his words said, "I kind of do like the way it is." He enjoyed both his science and math classes, and in fact, he stated that his favorite subject has "always been math since I've been little" (Malcolm, Interview, 2012).

However, it is interesting to note that despite math being his favorite subject and his STEM aspirations, he was enrolled in remedial math as a senior in high school. As he elaborated, senior math, the name he gave his math class, included everything from algebra to geometry. He added the class is designed to go "over everything you learned in other classes. It's all review" (Malcolm, Interview, 2012). Knowing of his engineering aspirations at the time, I asked if he sought higher level math courses to which Malcolm stated, "I never thought about calculus. I don't go that deep" (Malcolm, Interview, 2012). This quote suggested that Malcolm did not get the support he needed over the course of his schooling to reach a pre-college level math class more typical of a student on an engineering trajectory.

During the fall of his senior year in high school, I asked which science class he was taking to support his engineering trajectory. To my surprise, Malcolm answered that he was not enrolled in a science course, because he had already taken three years of science satisfying graduation requirements. His school advisors informed him that the state required only three science courses for high school graduation, and science was only an elective in his senior year (Field notes, 2012). Malcolm was unaware of the importance in being able to show colleges that

he was continuing to maintain a rigorous class load including science during his final year of high school and demonstrate his effort to prepare for an engineering trajectory.

After learning from me that science was important for his career trajectory, he opted to enroll in physics the second semester of his senior year. After he had been in class for a few weeks, I inquired how the class was progressing. Malcolm's first words to answer my query were, "well, you can expect a lot of notes." I pushed on this comment and asked what sort of laboratory investigations he was conducting in class. He replied, "Labs, we haven't done them lately. I don't know if this teacher actually does them. Most physics class, yeah, you'll see labs everywhere. Different stations. People working on different stuff. But not in my physics class" (Malcolm, Interview, 2012). I asked Malcolm if he knew why there was an absence of scientific investigations in his class. Malcolm was in a newly created section of physics in a non-science classroom and stated, "this is a new physics class so it's not in a physics area so he wouldn't do labs in there. Other classes are set up for physics, granite tops [in the lab bench area]" (Malcolm, Interview, 2012). This was Malcolm's hypothesis, not a reason given by his teacher for the absence of experiential lessons. According to Malcolm, "[The teacher] never said it but I figured. But I don't know if it's up to him [to decide whether to do labs]" (Malcolm, Interview, 2012).

I probed to see what Malcolm was learning in physics class. When pushed to answer what else happens in class besides note-taking, he added, "you expect to learn something different almost everyday. You can talk about a car. Change in velocity of a car. Change in time. Sometimes they actually do math in physics. Looking at the area of space. Different stuff like that, just mixing it up" (Malcolm, Interview, 2012). Malcolm was able to identify some topics of study but laboratory investigating of the concepts were not available to Malcolm and his classmates.

We discussed whether Malcolm would change anything about his science class. He first said, “Not really. I kind of do like the way it is”. He suggested lab activities might be something to change but tempered his response with acceptance of the way class is being taught. He stated, “Labs is just another way of looking at stuff but notes is good, too. Either way, I don’t complain”. He quickly reaffirmed that the current way the physics class was being taught was fine by him and he could be successful “If I stay on task. Pay attention. Doing what I have to do. Get the homework done” (Malcolm, Interview, 2012). Malcolm’s classroom experience has been normalized throughout his schooling that he willingly accepts the fact they rarely do lab activities in a science classroom. In our conversation, he returned to what a visitor to his class might expect to observe, “So pretty much you’d expect walking in here notes. You’ll actually learn a lot off different things. It’s just a matter of you paying attention and keeping up with what’s going on” (Malcolm, Interview, 2012). Malcolm also returned to his acceptance of rote instruction and stated, “I learn okay taking notes, it helps out. Some stuff I can actually hear and take it in but some stuff I actually do have to write down to understand it better” (Malcolm, Interview, 2012). In this instance, Malcolm reaffirmed the inscribed importance of note-taking as a way to learn science concepts.

Malcolm’s roles at the youth center and GET City summer program and his participation in extracurricular activities with his church and school band indicate he is a leader and role model in the community. Coupled with strong interest in STEM pathways, he seemingly has a bright future as a college student. But, Malcolm’s science narratives leading up to college made me wonder how he became so ill-prepared to study engineering or kinesiology in college.

Portrait of Justice

I met Justice through the teen director at the youth center. I had previously spoken with the teen director about my desire to invite youth to investigate race-based equity issues associated with pursuing and attending college for STEM careers. She quickly recommended and introduced me to Justice. During the introduction, Justice told me that she planned to go to college. The teen director had high expectations for the youth at the center and saw great potential in Justice. The high expectations were instilled with love and support to which Justice responded in-kind.

Over time, I learned that the youth center is an important place for Justice. The youth center provided a space to develop and grow as a young adult. Justice felt a sense of belonging at the youth center surrounded by people she cared for and received care from. The teen director was an enthusiastic nurturer who helped youth build self-esteem. The youth center also provided opportunities to develop leadership skills, gain work experience and earn a paycheck as a junior staff member. Justice was selected as the Youth of the Year by the staff at the center for her involvement and positive participation. Justice is actively involved at the club beyond her two-hour shifts each day. In her remaining time at the youth center, she participates in teen programs, hangs out with friends and seeks tutoring to support her especially in physics. The youth center was essentially a home away from home for Justice.

At her actual home, Justice lives with her mother and brother in a modest rental home near the youth center. I have found Justice to be fairly guarded about her family, and I am cautious not to press too hard for her to share her home life. I have never heard her speak about her father. Justice often makes comments regarding her mother but never with great details. From what Justice has shared, her mother's work situation has not been stable. She had a job at

one point but more recently, I learned she is out of work. I have sensed tension when Justice talks about her mother being out and about leaving her to look after her younger sibling.

Given the inconsistent work status of her mother, Justice has mentioned the family depends on government assistance for housing and food. I have given Justice rides to her home on a few occasions during which she has lamented that their home is within yards of an adult entertainment venue. During one ride home, she pointed out other homes that were available for rent and "nicer". For Justice, nicer meant the house was bigger, in better condition, and located away from undesired businesses. She wondered if the assistance money would be enough for her family to move into the nicer home (Field notes).

For Justice, financial struggle was a strong narrative and lived reality. In the paragraphs that follow, I reiterate some of the narratives told by Justice related to money. The point of describing the financial narrative is not to characterize Justice and her family's financial situation. Nor is the intention to romanticize Justice as another young Black woman caught in the culture of poverty. Rather, my goal is to bring light to the ways socioeconomic status intersects with race and comes to bear on educational opportunities for youth of color and the pursuit of STEM aspirations. Despite financial hardships, Justice aspired toward a rewarding career driven by personal commitments to a better world and for financial stability. Financial concern both motivated Justice toward her aspiration but also presented obstacles that hindered learning.

Justice earned modest paychecks working up to ten hours per week at minimum wage as a junior staff member but added that $25 of each paycheck went directly to her mother to help with family expenses. From what was left, Justice paid for her monthly cell phone bill. Justice also budgeted to pay her own way for a driver's education course (Field notes, 2013). Any extra expense was a large financial burden and often a great stressor. For example, Justice's cell phone

was damaged and stopped working. A replacement was $100, far more than she had on hand and more than a single paycheck. Justice had to go several weeks without a phone before she was able to buy a discounted replacement phone. Another time, Justice was not sure she could attend the student leadership conference with the group if it meant giving up her shift and losing three hours of pay. We arranged for Justice to not lose pay and she still attended the conference with the group.

Justice was very aware of the money spent by those around her especially for her. For example, Justice demonstrated deep appreciation and awareness each time I brought snacks for our group sessions. She thanked me profusely for bringing the snacks and always added that she hoped I hadn't spent too much money out of my own pocket for her and the group. Through her gratitude, Justice illuminated how hyperaware she was to the ways money is a source of inequities in the everyday lives especially for those faced with financial struggle.

Despite challenges Justice faced in her own life especially with financial issues, she is selflessly committed to making the community a better place and having a positive impact in the lives of those around her. For example, I observed her passion for working with children at the youth center in reinforcing ways. I watched her handle the misbehavior of a young boy. Rather than being punitive, Justice took a nurturing approach and counseled the boy about proper behavior and added, "you're too cute to be causing trouble" (Justice, Field notes, 2012). The boy smiled and went back to playing nicely with the other kids. Justice spread her positive energy and focused on the good rather than the bad.

Beyond the youth center, Justice sought other ways to brighten the lives of others in the community. She enjoyed going to a local adult care home to spend time visiting with the residents. She bemoaned that too often, the elderly get sent to adult homes and they don't have

anyone to truly spend time with them. Justice felt that the family members of the elderly do not visit often enough. So, she would go to visit the residents at a local adult home in the community. She beamed as she told about how some of the elderly would consider her more of a granddaughter than their real grandchildren (Justice, Interview, 2012). But, Justice didn't visit for her own benefit, but rather her compassion for other people guided her actions.

As I got to know Justice, she also displayed a playful side to compliment her compassionate side. I have shared the following story to remind us that Justice has a zest for life and having fun to offset the stories of struggle and perseverance. Justice figured out how to bait me with statements that I would take at face value only for her to laugh and say, "J-K! J-K!". J-K meant just kidding. I finally caught her trying to feed me a story. I saw her at the youth center and she told me that she had been in a fight at school. She continued to explain that she was suspended from school and she wouldn't be able to work on the project. I answered back, "Did you win the fight?" Expecting a different reaction from me, perhaps one of alarm, she paused for a moment before giving me a congratulatory high five. To be certain that I had caught onto the ruse, Justice later asked, "You know I didn't really get in a fight, right?"

On one hand, Justice routinely encountered challenges that life presented. On the other side, she continued to strive for a better situation in life. And thus, the struggles and joys associated with life became the motivation for school success. Justice wanted to be successful in high school in order to attend college. Justice decided that she wanted to become a pediatrician in order to pursue her dreams of making the world a better place, work with children and join a pathway toward financial opportunity.

Justice also connected her desire to be a medical doctor to the issues in her community. For example, Justice talked about a 15 year old peer that had to be admitted to hospital due to

diabetes caused by obesity during one of our sessions (Justice, Session Transcript, 2012). She linked obesity with food and nutrition issues that would later be a central part of action taken by the youth as described in Chapter 6.

In the following section, I describe the science narrative told by Justice, an aspiring pediatrician, to see what kind of STEM experiences she had received to prepare her for college and career.

Justice's Science Narrative

In order to become a pediatrician, Justice recognized that science is an integral part of the preparation given the heavy science based course requirements of the profession. She described one link between chemistry and patient care stating, "You have to know what chemicals to mix with what to make medicines" (Justice, Interview, 2012). Justice's decision to make a link between chemistry and her aspiration is telling with regards to her science experiences in school. Justice made a connection to a course she had yet to take, chemistry, rather than with classes she had or was currently enrolled in including biology, environmental science, or physics. Justice stated, "Science is not my favorite subject" and added, "it's hard for me to do sometimes" despite her STEM aspirations (Justice, Interview, 2012).

I was hopeful that Justice had positive experiences with science so I asked her to describe her best experience in science. She pointed to the time she made a model of the planets in middle school in earth science. For Justice, she prefers working on projects to learn rather than lectures and worksheets. Making a model allowed Justice to draw upon her creativity. Justice spoke with pride describing how she made note cards and had the opportunity to explain her understanding of the solar system. When asked what stood out to her about this experience of constructing a model of the solar system, she laughed and stated that she learned "stars are made of gas". But

more importantly for her, she was now able to explain it to others including "when I come [to the youth center], the little kids don't know how to do their homework. I know how to help them do it" (Justice, Interview, 2012).

In picking her best experience, Justice skipped over biology and environmental science from her 9th and 10th grade years at Murphy and chose a project from middle school. Justice expressed that her dislike of science started in middle school. For Justice, school science was "boring because we didn't do nothing but like book work, answer questions, read a chapter, answer questions, read a chapter, answer questions. Really wasn't no labs or anything fun" (Justice, Interview, 2012). Once Justice started high school, the biggest difference she noticed is that "there is more work and that you learn more [content]" (Justice, Interview, 2012).

Justice is highly critical of her school science experience. For Justice, one of the hallmarks of a science classroom is the opportunity to engage in laboratory investigations "like dissections" and learning through work on projects. Rather, science class was characterized by repetitive exercises and busy work. In her 10th grade environmental science class, she indicated the class did a lab-based lesson but once a month. Labs were less frequent in her freshman biology class. Justice lamented that her class does not have many opportunities to do investigations or projects. She noted how the laboratory space available is under-utilized in her science classes. She questioned the purpose of the lab bench area as she stated, "they have like a little shower, eye thing for your eyes just in case chemicals get in your eyes, which we don't do nothing with chemicals, so I don't know why we have that". If given the opportunity to change the way science classes are taught, she would include "more labs and make it funner" (Justice, Interview, 2012).

Justice noticed other issues in class that hindered her science learning. According to Justice, class is "chaotic" and the teacher has trouble getting the other students to "sit down and shut up". The tone of her voice and the choice words "shut up" revealed her frustration with the fact that the teacher was forced to handle disciplinary issues rather than teach and support students during class. Justice was frustrated with the teacher not being able to manage the classroom and the peers causing the disruptions. As a result of the bad behavior of some students, Justice had to stay after school on her own time in order to get help from the teacher until she understood the lessons. Justice felt she was able to understand the content after school because there are not 30 students at one time for the teacher to assist or manage so she is able to ask all the questions she wants.

At the same time, Justice did not blame teachers and suggested that teachers are constrained by forces outside the building. "They have to do what the school district asks them to. They have to teach what they have to teach. They can't just make up their own lessons" (Justice, Interview, 2012).

Portrait of Lil c

Lil c heard about our project from Justice and the rest of the participants and therefore came into the project after we had started our initial YPAR investigations. Lil c was eager to come to our next session after the teen director at the youth center introduced us. The teen director felt Lil c would be a great addition to our project. As I described the project, I touched on the investigations we had started on whether race matters in school to which she said, "Preach" (Lil c, Field Notes, 2012). Right away, I sensed she brought to the project a strong awareness of social injustices in the world around her that motivated her toward participation. I was impressed by her forwardness to want to participate after her first session with us and how quickly she

jumped in and shared in the tasks and responsibilities we had created. Lil c's enthusiasm to get involved was constant throughout the project. For example, I mentioned the possibility of presenting our work at a conference. Before I could share details of the conference, Lil c chimed in, "I'll do it" (Lil c, Field notes, 2012).

Lil c is also a fixture at the youth center as a junior staff member and teen attendee. As required of all youth who wish to be junior staff, Lil c exemplified leadership qualities, responsibility and compassion. I was able to observe Lil c in action since I visited the youth center frequently, even on days we were not scheduled to meet for our project. I happened to see her on such a day and noticed a sticker she put on her shirt. She found an extra "Hello, My Name Is" sticker and wrote, "Lil c loves you" (Field notes, 2013). The message reflected her kind and caring attributes that enabled her to work successfully with younger children at the youth center. Her good rapport with the adult staff and youth members earned her consideration as a finalist for Youth of the Year, the same honor Justice received the previous year.

Away from the youth center, Lil c lives with her mother and younger sister in an apartment. Lil c has a strong relationship with her mother. At home, Lil c's mother has made it known to her daughters that education is a top priority. Her mother is actively involved in school and carefully monitors Lil c's activities outside of school including participation in this project. I have communicated frequently with Lil c's mother regarding activities of the project sharing with her the accomplishments by her daughter. Lil c's mother has supported and advocated for this project, provided ideas and suggestions for YPAR investigations, offered contacts from her networks, and attended the workshop presentation at the youth leadership conference. At the conference, Lil c's mother and used the opportunity to visit the conference resource fair to gather as much information as possible to support Lil c and her younger sister to plan ahead for college.

Lil c also recognizes the importance of her education and is a successful and dedicated student. She takes pride in her successes and works hard to maintain her grades with her future goals in mind. Lil c has also experienced success outside of school. For example, she entered a community-wide Martin Luther King Jr. essay contest for students and received third place among high school entries. I inquired with the youth to see if they already entered through their school only to discover they were not made aware of the essay contest. I offered to be the adult sponsor as required by the essay contest rules. Consistent with her quick response to opportunity as explained above, Lil c chose to enter the essay contest. Lil c wrote her essay and I offered constructive feedback in an iterative process that included two meetings. A few weeks after the close of the contest, Lil c informed me that her essay was selected for recognition and came with a $150 prize. In addition, Lil c attended the awards luncheon with her mother and had her picture in the local newspaper with the other essay contest winners.

At times, Lil c and her mother did clash especially over social relationships. I share this insight to acknowledge the complex nature of relationships between parent and child that have implications on academic success. My intention is not to move the focus away from the race and racism but to show that there can be a cumulative effect that can compromise student progress. For example, Lil c's mother was very involved whenever she socialized with boys. Lil c's mother intervened and ended relationships with boys if she did not approve of him. This created tension between mother and daughter on two occasions during the time I have worked with Lil c. One incident led to Lil c to move out and she temporarily lived with her aunt. The tension between mother and daughter caused Lil c to fall behind in school, because she had trouble getting to school. Lil c had to enroll in a credit recovery program after school to stay on track. Lil c mentioned her mother was worried that she would end up pregnant and not be able to finish

school. Lil c added that her mother needed to be more concerned with her younger sister. “I bet you that [my sister] will end up pregnant before me. [My mom] thinks she’s innocent” (Lil c, Field notes, 2013). Lil c’s comment is filled with tension of wanting her mother to know that she is capable of make sound decisions in her own life and the pressure of being the oldest female child.

Lil c was forward in acknowledging injustices in the world around her as she explicitly named them across several conversations. In recognizing that people are marginalized for reasons that included race, Lil c is guarded in her approach to the world and the people around her. For example, she indicated to me that she has learned to “trust no one” (Lil c, Field notes, 2012). Lil c told me was about the time in middle school that she was accused of pushing down a teacher while being escorted to the principal’s office for another issue in class that she had been accused. Lil c explained that she tried to pull her arm out of the teacher’s excessive grip. Coincidently, the teacher tripped. The teacher got upset and wrongly accused Lil c of pushing her to the ground. As an African American female student, she found that she did not have a voice with the administrators who accepted the teacher’s version of what transpired in the hallway. She was suspended from school, but Lil c’s mother went to the school board to have the wrongful decision overturned.

Another incident in which Lil c felt marginalized occurred during basketball tryouts for the school team. Lil c loved playing basketball and she aspired to play professionally. During her junior year, she tried out for the school team but was told due to medical reasons that she could not complete tryouts. According to Lil c, the coach expressed concern about Lil c’s asthma and decided she could not continue with tryouts despite being cleared by her medical doctor. She felt that the coach did not like her and therefore used asthma as an excuse to keep her off the team.

The doctor had not placed restrictions on her ability to play sports. The incident reinforced her stance to not trust other people.

For Lil c, the wrongs she experienced and observed fueled her career aspirations to make the world more just. Lil c developed an interest in forensic science. Forensic science offered Lil c an attractive option aligned to her quest for justice. She admitted that her interest was also partly due to the popularity of television shows that featured forensic investigators solving crimes. She enrolled in forensic science during her 11th grade year. The class supported her interest in forensics as she learned how to use science to solve crimes.

Lil c's Science Narrative

Science was essential to Lil c's career aspirations. In addition to forensic science, she expressed interest in veterinary and nursing careers. But, Lil c's science experiences were varied in the degree to which they supported her trajectory. Forensic science class directly reinforced her STEM aspirations. But, Lil c also encountered overcrowded classrooms and busywork that were detrimental toward a STEM trajectory.

Lil c believed that engaging with real materials to conduct investigations was important in science learning. Thus, one of Lil c's memorable experiences in science was during an acids and bases lab in chemistry. Students made an indicator solution from red cabbage to test the acidity of different substances. She vividly recalled how she heated a mix of red cabbage pieces and water over a Bunsen burner and collected the purple liquid that was produced. The blue flame of the Bunsen burner was particularly memorable for Lil c. She accurately explained how a blue flame is hotter than an orange flame. When I asked Lil c why she chose this as her best science experience, she answered, "it was hands on" (Lil c, Interview, 2012). Likewise, forensic science provided positive learning experiences for Lil c. She enjoyed the investigations and

opportunities to process mock crime scenes. The class also provided a practical application of science to a career pathway. Lil c felt that what she was learning connected to career possibilities.

Class size in chemistry was an issue for Lil c during her 10th grade year. In a class with 45 other students, her biggest complaint was the difficulty in getting help from the teacher individually and during group work. Cautious of being overly critical of the teacher, Lil c credited the teacher for still including opportunities to engage in chemistry investigations despite the potential safety concerns with the number of students in the lab. While Lil c was excited to do labs semi-regularly, she disliked that it was hard to get help from the teacher with so many small groups working in the lab. While the teacher tried to help one group, other students would be "running around and being loud" (Lil c, Field notes, 2012). So, if a student needed extra help, the student would have to arrange to meet the teacher at a time outside of the class period.

Lil c described the rest of the week in chemistry as "boring" and stated that during class she "slept a lot" (Lil c, Field notes, 2012). The class usually took notes and completed worksheets. And when she was finished her work, she boasted that she usually slept. Sleeping was essentially sanctioned in that the teacher didn't care what students chose to do after they finished the assignments. At least, according to Lil c, the teacher never stopped her from sleeping if her classwork was finished (Lil c, Field notes, 2012).

Lil c also spoke about how much she disliked tests in science. She argued that the test items did not match the content the students had been studying (Lil c, Interview, 2012). Lil c did add that the teacher often allowed students to use their notes during tests but that note-taking was optional. She indicated that she "sometimes" kept notes. I asked how could it be that the test did not reflect what the students had studied in class. She stated that the teachers at her school aren't

allowed to make the tests and that someone from the district probably makes them. Therefore, there is a mismatch between what students do in class and what they are assessed on.

Lil c's frustrations with aspects of her science experiences, desire to be successful in school and enthusiasm to actively fight for change came together through her participation in the YPAR project. The combination of commitments enabled her to integrate into the project and be a valuable team member.

Portrait of Caesar

In much the same way as many of the youth in the project, the teen director at the youth center introduced me to Caesar who at the time was in the 9th grade. At first, I didn't know Caesar was Malcolm's younger brother. Neither of them let on that they were siblings. Despite having spoken with Malcolm on many occasions prior to the commencement of this project, Caesar didn't enter the conversations. During the initial sessions, I started to put the pieces together through their conversations and interactions with the other youth. Caesar shared a mutual friend with Malcolm that had come to some of our meetings, and they spoke of spending time together at the house. Needless to say, Caesar was a little more challenging to get to know. I noticed his reaction to me was little more skeptical before we started to build a relationship as might be expected upon meeting someone for the first time. Our slow developing relationship is a reminder of the importance of the researcher-participant relationship. Engaging in YPAR and humanizing research cannot be forced, and the time needed to build relationships varies between the researcher and each individual participant.

Caesar participated in the project midway through the summer before 10th grade when new opportunities to pursue his sports interests became available. He joined the school football team and attended daily practices. Football practice overlapped with our project sessions forcing

Caesar to step away from the project. After football season, Caesar added boxing to his out of school activities, which is not bound by seasons, so is a regular activity after school. Although boxing was new for Caesar, he showed dedication to the sport. For example, he goes on training runs on his own as part of his conditioning. We were speaking at the youth center about his progress with boxing during a thunderstorm as he was preparing to go for a run. Unfortunately, the weather kept him from going out for a run that day causing genuine disappointment. The purpose of this story is to show that Caesar had to make a choice, and he committed himself to his decision. Prior to new opportunities to follow his athletic endeavors, Caesar regularly participated and contributed to our YPAR investigations.

Prior to taking up football and boxing, Caesar attended the youth center everyday after school. In part, he was at the club since his father, Malcolm and his younger sister were all there. He was also drawn to the club to play basketball during open gym sessions for the teen members. I adjusted our meetings around the work schedules of the three junior staff members in the project, but Caesar would remind me to also schedule around open gym. Thus, he was able to participate in the project and still join his friends for basketball. Like Malcolm, Caesar loved sports.

Caesar was quieter that the other participants in general perhaps because was younger than most of the participants. He was less outspoken during our group sessions but would periodically jump into conversations. What I learned about Caesar was that he was more likely to inject himself into a conversation in the role of the jokester of the group. He did not let opportunities pass to playfully add a wise crack or chastise fellow group members. He took silly pictures with group members using built in cameras on the laptop or iPad and otherwise helped us laugh to relieve some of the intensity of YPAR investigations. During a long research session

in the summer, Caesar performed a humorous dance that left the rest of the group laughing hysterically. Caesar's ability to have fun with the group helped alleviate the intensity of working on issues related to race and racism.

As a 9th grader, Caesar mentioned interest in engineering like his brother (Caesar, Interview, 2012). He was also a past participant in the informal science program, GET City, at the youth center. I found that Caesar's interests in school and future were still being defined. Given that he was relatively early in his high school career, he had yet to fully consider how science education might support an engineering trajectory.

Caesar's Science Narrative

Caesar's interest in engineering grew from his experience in GET City. GET City was where Caesar had his best science experience. I asked what was memorable about the experience and he stated, "Because it teaches about the environment and recycling" (Caesar, Interview, 2012). He recalled that he enjoyed participating in the program for the activities.

Caesar had memorable experiences outside of school with science but he was much more disenfranchised by school science. When I asked what an observer might expect to see in his 9th grade biology class on any given day, he replied, "Nothing". Caesar added, "We learn about the same stuff. I was in the class for two semesters. Same exact class. I passed it but I'm taking the same class" (Caesar, Interview, 2012). The biology sequence is divided into two semesters (Biology 1 and Biology 2) and usually taken across consecutive semesters by students in order to fulfill the full year state requirement for graduation. From what Caesar told me, he repeat the same content even if the classes were supposed to be different. Rather than getting the full year sequence, Caesar was adamant that the school placed him in Biology 1 for a second time despite as he pointed out received a passing grade on the first attempt (Session Field notes, 2013). This

seemed highly unusual that a student would repeat the same course if they passed the first time. I wondered whether the content seemed to be repetitive or perhaps the teacher repeated themes. I was unable to confirm whether Caesar repeated Biology 1. Regardless, the perception of learning the same content twice indicated a problem in his science experience.

Given the unusual situation of learning the same content twice, I asked Caesar if he would change anything. He answered, "Nothing". As for why he was content to learn the same material twice, he replied, "I like the spot where I'm at the class. I like the grade in there. I want nothing to change" (Caesar, Interview, 2012). Caesar was satisfied with his B letter grade that he was maintaining and having to learn new content could jeopardize his grade. Thus, the grade was more important than learning new content and being in the correct sequence of courses.

On the topic of favorite subject in school, Caesar enjoyed gym class because they get to play basketball everyday. As for a second favorite subject, he answered, "Nothing. I don't like no other class." Pressed as to what he didn't like about his other classes, he stated, "Everything. Teachers don't know how to teach" (Caesar, Interview, 2012). For Caesar, school was reduced to the experience of doing assignments in the form of busywork for a grade. He explained, "They give us an assignment and don't explain what we're supposed to do. They just give it to us. Cause I do it on my own, takes me a long time though. I figure it out by myself. Notes, read the directions. Just do it". I inquired a second time whether he stood by his desire to not change anything about his school experiences. He answered, "Yep. Cause I'm doing it by myself and get a better grade" (Caesar, Interview, 2012).

Caesar's narratives raised questions about whether school science experiences would ultimately sustain or support his engineering aspirations. Across the youth narratives, from

Caesar in his freshman year to Malcolm as a senior, the impact of school science experience on STEM trajectories provided a foundation for YPAR investigations.

Portrait of Deelilah

I have come to know Deelilah as perhaps the most candid participant especially when she describes the ways she has been marginalized in school. Our group conversations on systematic oppression resonated with Deelilah in such a way that she often openly shared her stories about school experiences. The project was a venue for her to be heard and find solidarity in the struggle against oppressive forces. Although I intended to invite high school students to participate in the project, the teen director at the youth center strongly endorsed Deelilah as an 8th grade student. The teen director, as she did with so many of the youth, was personally invested in Deelilah's success. She declared the Deelilah would go to college in my presence. She wanted Deelilah to join the project early to help her understand and negotiate the obstacles to college faced by students of color. Currently, she is at Murphy High School with the rest of the participants as a 9th grader.

I intentionally present the contrast between Deelilah that I know and the Deelilah with a reputation for getting into altercations. I know Deelilah as a friendly, smart, concerned and thoughtful young person. So, I was surprised the first time I heard that Deelilah had been in a fight. The dichotomy forced me to consider how youth are perceived in different spaces and how YPAR can allow youth to author a different reputation. I first learned of Deelilah's reputation for fighting when she missed a few of our sessions as her mother kept her at home under restrictions. Another incident happened outside the youth center right before our group was to meet. I saw her out in front of the youth center as I arrived and headed for the main entrance. I walked right by Deelilah and we exchanged greetings. A short while later as we prepared to start our weekly

session, Justice asked whether I knew that Deelilah was suspended from the youth center for fighting and that she wouldn't be able to join us. I countered that I saw her outside and expected her to join us momentarily. Justice elaborated that the fight had just happened probably moments after I saw Deelilah. As I show throughout the rest of this investigation, Deelilah builds a reputation as a fighter for social justice.

I see Deelilah at the club on a regular basis throughout the school year even on days we don't meet for the project. There have been occasional periods such as the summer where she was not in attendance. At the youth center, the teen director was her main backer but all staff members know her. Deelilah plans to follow in the footsteps of Malcolm, Justice and Lil c before her and serve as a junior staff member at the youth center when she is old enough to work. Working at the youth center would be very convenient as her family residence is within walking distance.

Deelilah is closely connected to her family especially her grandmother. Deelilah lives with her mother and an older and younger brother but spends most weekends across town at her grandmother's house with her younger brother. Deelilah offered to ask her grandmother to be a chaperone for one of our project outings. Deelilah's mother has been supportive of her daughter's participation in the project. Deelilah's mother told me she knows Justice, whom she thinks highly of, and the two girls talked about the project.

Deelilah has been successful in school and has aspirations for her future. According to Deelilah, she was in the highest math and science classes in 8th grade. Yet, she is not recognized as a top student by her teachers who instead position her to fail through false pre-conceptions that only serve to marginalize her. The focal point is often her behavior instead of appreciating her intellectual ability and potential to go to college. As a result, Deelilah speaks of the fairness or

the lack of around various school experiences. For Deelilah, the notion of fairness is to make the world a more equitable place. For Deelilah, one pathway to fairness is to pursue a career in law enforcement. Although Deelilah enjoys math and is a good science student, she hasn't expressed explicit STEM aspirations. Much like Lil c, Deelilah's lived experiences have led her to consider a career in which she can have power to deliver fairness.

Deelilah's Science Narrative

I periodically asked Deelilah about her science experiences but I found that she did not have many events that stood out. I implored her to think of at least one memorable science experience but that proved to be a challenge. In the 9th grade, Deelilah was in biology so I asked what she was studying and she told me about the pond water lab. The teacher brought in pond water samples so that the students could look for unicellular organisms under a microscope. The class looked at pond water samples and drew the organisms they found. Deelilah enjoyed being able to see what was living in the pond water and documented what she found. While Deelilah found the pond water activity in biology class to be interesting, she didn't feel strongly that this was particularly memorable. She bluntly stated that science was not her favorite class.

Deelilah's favorite subject, math, fell under the STEM umbrella. Just as Deelilah indicated for science, she did not identify any single experience in math that was memorable. What she liked most about math was being able to help other students. She was confident in her ability to do math and really liked the problem solving aspect.

While math was Deelilah's favorite school subject, she told me that she was equally successful in her science classes. When she joined the project as an 8th grade student, she was enrolled in Earth science that according to her was a high school level class. She was proud to be in an advanced science class but negative experiences diminished her enthusiasm. For example,

Deelilah felt marginalized by her 8th grade science teacher one the first day of school. The teacher asked whether she was the younger sibling of a boy who was notorious for bad behavior at the school. The teacher identified the relationship through the family name. Deelilah felt it was unfair for the teacher to judge and label her as a potential problem-causing student based on the reputation of her brother.

Likewise, the transition from middle school to high school did not support Deelilah's continued growth and excellence in her best school subject, math. I wrote in my field notes that in 8th grade, Deelilah told me she had taken Honors Algebra I. When she arrived at the high school, she was placed in Algebra I instead of the next math course in the progression. Her guidance counselor told her that middle school math didn't count and that she would start in Algebra I with all the freshmen (Field notes, 2013). Well into her freshman year, she complained that she was bored in her math class having to repeat material she had already completed the previous year. Instead of providing Deelilah with more advanced and challenging math concepts, she was asked to help the other students when she finished her assignments early. Although she liked to help, she described her frustration with not being challenged and trying to help her peers that were more interested in socializing with others instead of learning.

Deelilah joined the project early as a middle school student so she did not have as many science experiences in high school as the rest of the youth in the project. Yet, entering high school, her learning experiences left her feeling marginalized by the system because of teachers and counselors that predetermined her trajectory through their actions. And, given the science narratives of the older participants, school science did not seem to offer much hope for supporting and preparing the youth to be successful.

Across the Science Narratives

I looked across the youth science narratives for crosscutting themes as told by the participants. I found four main themes: (1) the youth saw little connection between school science and STEM aspirations; (2) the youth were not positioned to advocate for their own science learning; (3) the youth were subjected to the institutional narrative that limitations restrict the opportunity to do authentic science in school; and (4) the youths' school experiences included institutional racism. Throughout the narratives, youth recognized what was missing and that they desired in their science experiences but were subjected on most days to instruction that provided little opportunity to engage the content in ways they valued.

School Science and STEM Careers

The youth did not see a clear connection between the science content they learned in school and their future STEM careers. School science was an item on a checklist of high school graduation requirements. Except for Deelilah, the youth envisioned careers in STEM related fields as medical professionals, crime scene investigators, and engineers. Despite their STEM aspirations, the youth rarely mentioned how their science classes were preparing them for a career. When I asked youth to explain the link between science learning and career, they made broad connections. For example, Justice imagined that chemistry, a course she had not taken at the time, would be useful to a doctor who prescribes medicine to patients. But she did not mention ways biology or environmental science was connected to health care issues despite having taken both classes.

In addition, the youth were not always aware of which science courses supported certain career aspirations. In Malcolm's case, he wasn't aware of how physics might support his engineering aspiration and ended up starting his senior year without a science class. In the second semester, he enrolled in science only after we had a conversation about preparation for an

engineering trajectory. In the conversation, I asked about which courses he thought supported his engineering trajectory. In his response, Malcolm loosely connected engineering to math but could not provide concrete examples of how math applied to the work of engineers. He did not mention science classes that supported his engineering goals.

In Malcolm's experience, the primary goal of the school was to insure students satisfied the state graduation requirements rather than supporting students to make course selections that connected to career aspirations. Rather than encouraging students to maintain a rigorous course load that included a fourth year of STEM classes, students were steered away from challenging courses in favor of electives to avoid the risk of failing the class and jeopardizing the school's graduation rate. Therefore, Malcolm started his senior year without a science class after being informed by his guidance counselor that he had satisfied his science requirements. Despite getting into physics, based on Malcolm's description of the course, it would seem that the heavily notes and lecture based class was not well connected to preparing students for a problem solving career as an engineer.

In Lil c's case, forensic science made a more explicit and practical connection between science and career. Students were often tasked with investigating scenarios using crime scene evidence to solve the cases. For Lil c, science was used as a tool to test the evidence collected in the scenarios. In fact, the class was highly influential that she went from expressing interest in a veterinary career to forensic science. The intent is not to argue science classes must be used to train students for STEM careers. But, the science classes should be connected to careers by including science experiences that allow students to better understand ways science is applied in various careers and used as a tool to explain the world around us.

Youth Are Not to Positioned Advocate for Their Own Science Learning

In the second theme to emerge, the youth sought but were not able to advocate for meaningful science experiences that placed them as active participants in the learning process. The youth wanted opportunities to conduct more science investigations, use technology, work on group activities, and answer perplexing questions. Instead, the primary form of instruction in science relied heavily on low cognitive demand tasks. The youth did not have a voice with their teachers or school leaders to request more science experiences that placed students in the role of doer and thinker. In field notes from a conversation with the group, I wrote "[Justice and Caesar] did express some hesitation at the idea I suggested as to whether they could take a case to the principal. They suggested that they might get shut down quickly". This was a reoccurring narrative regarding talking with school leaders. Caesar stated, "schools aren't gonna listen" to the youth. The comment suggests that the power to make change lies in the hands of those in control. In this case, the school leaders control whether changes can be made within the school and students of color have very little voice. Youth were also told by teachers that forces over them dictated much of what they were able to do in classrooms.

Unable to advocate for their science learning, the youth were resigned to go along with the way things were in science class. Yet, the youth were well aware of the lasting impact of active participation in science through their experiences. The most striking and problematic aspect of the narratives is the recognition by the students that student-centered experiences have been most beneficial in their science experiences but that the youth have very little opportunity to demand science opportunities that are meaningful and connected to STEM aspirations. The youth valued meaningful science experiences that inspired curiosity and enabled them to use their knowledge to either complete relevant tasks or to support others. For example, Malcolm recalled the visually captivating demonstration by his science teacher lighting his alcohol soaked

hand that led him to wonder how is it possible to avoid severe burns. Malcolm also referred to serving as an instructor for the informal science program in which he was able to share his knowledge with younger peers. Justice recalled the opportunity to build a model of the solar system that required her creativity and provided experiences she could share when assisting younger peers. Lil c gave a detailed account of the process they used in chemistry to create a pH solution with red cabbage to test acids and bases. Deelilah spoke of problem solving in math and the satisfaction from being able to figure out the solution. And although science was not her favorite subject, Deelilah conceded that the pond water investigation was at least interesting. For all of the participants, meaningful learning included a practical or applicable component that is not always found in didactic learning.

Unfortunately, the adults determined the science experiences in school with no input from students. In part, the reluctance in invite youth voice comes from the institutional narratives about school science as described in the next theme.

Institutional Narratives About School Science

The third theme identified institutional narratives about school science. At least two institutional narratives were most prominent in what youth said about their science experiences. One narrative focused on the limitations to what science experiences were possible in the classroom. The other narrative focused on the purpose of school as a set of steps to be completed. The institutional narratives impacted both the youth learning experiences and STEM trajectories.

The institutional narrative about limitations placed on science experiences pointed to lack of resources, available time, student behavior and class size that reduced science in school to instruction through taking notes, completing worksheets, reading text, and taking tests. Consequently, science was characterized by busywork instead of developing and acquiring

science practices and knowledge. Malcolm suggested the classroom where his physics class met was not equipped to do labs and characterized his physics experience as dominated by note taking. According to Justice, her science teacher was too pre-occupied with disruptive students to do labs and activities and be able to help students. Lil c talked about being in a huge chemistry class where it was hard to get help from the teacher. While according to Lil c, the chemistry teacher tried to do labs once a week but the rest of the time included busywork after which they could sleep without worry of drawing the ire of the teacher. Deelilah had lab activities less than once a month and the remainder of time was mostly spent on assignments and notes.

The second institutional narrative found in the stories youth told indicated that science classes at school were steps through which one must pass to move forward within the system. The youth felt powerless to advocate for engaging forms of science exploration, so they reluctantly accepted the excessive amount of busy work as a way to pass forward. When Caesar said that he doesn't mind that his biology class is repetitive because he can get a satisfactory grade speaks to way he had conformed to accept the institutional narrative. Caesar didn't trouble the busy work because he figured he could get a decent grade with minimal help from or interaction with the teacher. Malcolm suggested notes were fine by him because he could study them for a test. Justice was willing to go out of her way to get help after school to complete assignments if that's what she had to do. For Lil c, science class was expected to be boring although a student could gain time for sleep. The purpose of taking science class was reduced to getting a passing grade rather than engaging in interesting inquiries to further one's understanding and appreciation of phenomena and building capacity to succeed in STEM endeavors.

Institutionalized Racism

The fourth theme was an institutional narrative on the prevalence of racism in school experiences of the youth participants. The youth encountered racism through their classroom experiences and in their YPAR work. One way youth experienced racism was through low expectations. As discussed in their portraits, youth described instances when teachers at their school Murphy, a majority minority school, unfairly held low expectations of the students. On separate occasions, Justice and Deelilah were told by their teachers that they should consider working at fast food restaurants rather than aspiring for careers that require higher levels of education. Justice described encountering "people who say you'll be a janitor or work at BK [Burger King]". In field notes of one of our session, I noted that Deelilah "had teacher that told her 'why don't you work at McDs [McDonald's]' when she said she wanted to go into law enforcement". Caesar added, "[Teachers] tell us we can't do it". And Justice stated, "I think it's the way teachers give up on us" (Field notes, 2012).

The youth also experienced racism through the denial of quality science classroom instruction and opportunities to take additional science classes beyond the graduation requirements. As the youth indicated, their science experiences were dominated by low risk and low value busywork instead of authentic science investigations. The types of work assigned with the frequency experienced by students at Murphy unfairly disadvantages learners of color through the denial of science experiences like the ones supported by science education reform advocates. In another form of institutional racism, the guidance counselors intentionally advised youth of color against taking a fourth year of science or other academically rigorous classes. Malcolm was led to believe he did not need to take a fourth year of science regardless of his STEM aspirations. Similarly, Lil c was advised against taking math her senior year. The youth of color are placed at a competitive disadvantage when applying for college spots with students

who have four years of academically challenging course work. Upon entering college, youth of color are more likely to be placed in remedial courses especially in math to learn high school level content adding to their course load and tuition burdens. In Malcolm's first semester of college, he completed the Basic College Skills sequence of three courses designed to develop reading and writing skills that high school Language Arts should have provided. He still needs to take remedial math courses so that he can work toward reaching pre-calculus to meet the requirements of the kinesiology program.

Institutionalized racism disproportionately subverts the aspirations for those who can ill afford to be removed from pursuing STEM trajectories. Racism was systemically embedded in the school experiences of the participants. Youth stories from science learning experiences exposed the endemic ways racism is woven into school structures.

Connecting to CRT

The youth narratives about the school science experiences and STEM aspirations are powerful counternarratives to the ways youth of color are portrayed as learners. Counternarratives are an essential element of CRT in that there is strength within the stories of the marginalized youth, but also oppose the dominant narratives about learners of color in science endeavors. The youth demonstrated how racism has been institutionalized into the school structure counter to the narrative that schools are equitable spaces where each student that applies themselves to their academics will be able to pursue their aspirations. The youth exposed how racism is pervasive in their school science experiences and continues to deny youth of color STEM trajectories. Whether through seemingly benign action by providing limited science laboratory experiences or problematic teacher comments suggesting deeper, troubling beliefs about their students, racism is part of the school experience for youth of color. Later in Chapter 6,

the youth authored a counternarrative that moved them from being unable to advocate for their learning to impacting their learning *and* for their younger peers by teaching a science unit outside of school spaces in the community center.

As presented in Chapter 2, youth of color are frequently described by low test performance in the literature and in educational narratives that attempt to compare achievement between racial and ethnic groups. While not entirely unique, this dissertation contributes to the work that moves beyond retelling narratives through deficit perspectives and invited youth to share their narratives. In the narratives told by the youth, they echoed many of the challenges faced by students of color in science classrooms and revealed a strong desire to enter STEM career fields despite the data showing the lack of persistence in the STEM pipeline among people of color. In particular, the institutional narrative told by the youth as acquired from those around them underscores the endemic nature of racism as foretold by CRT. Furthermore, the acceptance of the institutional narratives by the youth, teachers, and school leaders cements the permanence of unequal science learning opportunities. Those with the most power and best positioned to make change, the teachers and school leaders, are complicit in the oppression of students of color. Without adult advocates, the youth, already rendered powerless by institutional narratives that there is nothing that can be done to change inequitable conditions, are left unable to advocate for themselves. But, through YPAR, youth discovered how to use research to legitimize their concerns with data and how to enter into spaces where they were better able to advocate for their learning.

For example, academic spaces are often sites of limited opportunities for youth to tell their stories given the expectations of associated credentials to be legitimized. That is, individuals in possession or in the process of obtaining advanced degrees generally conduct

academic research. In retelling the youth narratives in this dissertation, we have worked together so that youth voices are included in academic spaces. By entering traditionally forbidden academic spaces, the youth counternarratives are essential for opening the dialogue that critically interrogates how race and racism are lived experiences of the youth in their STEM experiences. Furthermore, youth advocated for themselves through social media and requested an opportunity to present their work in from of the school board.

Looking Forward

The portraits and science narratives of the youth provided the context for the YPAR investigations and strategic measures to counter the oppression encountered by students of color. YPAR was a tool for youth to enter into academic spaces by employing legitimate research practices and bring attention to narratives of race-based denial of STEM trajectories. YPAR enabled youth to critique science instruction used in classrooms that (under)serve youth of color. YPAR provides an evidence-based pathway to advocate for science learning opportunities that are meaningful. Research exposed how disparate learning opportunities between schools with different racial composition privileges students at the majority White school. Chapter 5 describes YPAR investigations and what the youth uncovered to show dissimilar learning opportunities based on race. Chapter 5 also presents youth participation in academic conference spaces. Chapter 6 describes how the youth took action to advocate for the science learning of youth of color by implementing a teaching unit for middle grades youth in the community designed with teaching practices that were missing in their own experiences.

CHAPTER 5

YOUTH IMMERSION IN YPAR

This chapter examines how the youth in my study engaged in YPAR to investigate the STEM opportunities available to them and to the students in their school community. Recall from the methodology chapter that participatory action research, including YPAR, has been used a research approach by marginalized populations to challenge oppressive structures and bring about positive change. In this case, youth of color were active participants in YPAR. The core of the youth's YPAR focused on investigating the opportunities they had to learn and engage in science as well as the support they received in the school setting to pursue STEM trajectories. Throughout this process, the youth planned investigations and used the tools of research to gather evidence for the ways youth of color are supported or marginalized at school to fulfill their STEM aspirations. They analyzed the data and revealed inequities in science learning for students at their school and developed strategies to take action. Lastly, they reflected on the research and actions taken toward social justice to inform their next steps.

In this chapter, I argue that the YPAR had an important impact on the youth in three ways. First, youth gained access and learned to use the tools of research to investigate and develop awareness of race and racism in science learning. For example, the youth learned to use the Internet to gather data, analyze documents, conduct observations, gather data as participant observers, and design and implement surveys. Second, the youth learned to author spaces where youth voice mattered. The youth took action by targeting particular audiences for their research findings. Finally, YPAR supported the youth to be critical thinkers on systemic issues that marginalize populations of color.

I also make the case that these three outcomes positioned the youth to take on the challenge of designing and teaching a nutrition unit to their younger peers in an effort to change opportunities to learn and engage science meaningfully in their community. While my discussion of the nutrition unit will be the focus of Chapter 6, I want to note in this chapter the cumulative nature of the YPAR work on students' understandings of racism and its impact on their STEM experiences and in their desire and ability to foster change.

To build this argument I begin with a very brief snapshot of the YPAR progression from its inception to its completion. My purpose in offering this brief snapshot is to immediately situate the narratives presented in this chapter and later in chapter 6. Then, I provide a rich account of the YPAR activities that led up to a mid-year student leadership conference. This account actually begins with a description of the leadership conference itself as it was a pivotal event that brought together all of the youth's efforts in advocating for students of color with STEM aspirations and is what spurred them on to the nutrition unit. Finally I discuss the three impacts mentioned above and why they mattered to the youth.

As you read this chapter and the next, keep in mind that I use a narrative style to tell the stories that emerged during the YPAR sessions in order to preserve as much as possible the authentic voices of the youth. While every effort is made to remain true to the emotions, concerns and commitments of the youth, my retelling inevitably filters the participant narratives that appear here. Nonetheless, the research experiences captured through the stories and voices of youth attempt to emphasize the moments where youth grapple with the complexity of systemic marginalization. The stories revealed the depth of passions of the youth that ranged from frustration and hopelessness to joy and triumph.

A Snapshot of YPAR Activities

Across the project, the youth accomplished many activities consistent with the four primary areas of YPAR. The youth established the problem to investigate and designed appropriate tools to gather data. The youth applied the analytic tools of research to make sense of the data. Based on their findings, they planned and took action to transform STEM trajectories for youth of color. Finally, they reflected on the outcomes of their research and action to evaluate impact and consider future YPAR activities. Table 5.1 provides an overview of the activities of YPAR youth engaged over the span of this project.

Table 5.1
List of YPAR Activities of the Youth Participants

Investigation	**Planning**

• Majority of the youth participants identified their interest in STEM related field.
• Group discussion on whether the high school one attends matters in terms of preparation to pursue STEM trajectories.
• Youth explored issues of race and racism in schools and society (discussions of current events – i.e., ban of ethnic studies in Arizona, the death of Trayvon Martin)
• Interviews of current college students about their high school science experiences.
• Internet investigation of school information (comparison of curriculum guides)
• Visit and observation of science classrooms and teacher interviews at a different school.
• Survey of youth at their school.
	• Identifying audiences
	  • Peers
	  • Community
	  • School leaders
	  • Broader networks
	• Identifying ways to disseminate information and take action
	  • Conference presentations
	  • Internet – social media sites
	  • Authoring videos and audio
	  • Presentation before the school board

Action	**Reflection**

• Development of social media including video and radio public service announcements and Internet presence.
• Conference presentations
  • MLK Student Leadership Conference
  • Academic science education conference
  • Community-based liberation conference
	• Evaluating audience feedback from conference presentations
	• Taking stock in relative success of actions taken

In the following paragraphs, I will provide a detailed account of a subset of YPAR activities that were used to prepare for the conference presentation. The youth applied and were accepted to present a workshop for a peer audience to share how YPAR can be used to investigate educational opportunities at any school. The youth identified specific research experiences and actions they wanted to include in the workshop to illustrate the steps of YPAR. They designed the workshop around the problem of opportunities and support to pursue STEM aspirations at their school that guided the investigation. They selected examples that illustrated and inspired the audience in understanding the components of YPAR and how YPAR might be implemented in other locations.

The Student Leadership Conference Workshop

While I will describe the Martin Luther King Jr. Student Leadership Conference workshop presentation in detail later, it is important to know that it was a culmination of their work in the YPAR project across a full year. I learned of the conference through a colleague on the organizing committee. The work of the youth fit the target audience and theme of the conference. The conference invited high school and college students to learn from each other and work together toward social justice. The conference presented an opportunity for youth to further engage in YPAR and added purpose for considering the findings of YPAR. I asked if the youth were interested in submitting a proposal for the conference to which they agreed.

The youth-led workshop presentation was consistent with the goals of YPAR and designed to inspire and provide YPAR as a framework to fellow youth of color in order to take on disparities in opportunity at their respective schools. The youth shared their work and provided examples of research that audience members would be able to emulate or modify for

their context specific implementation. Youth modeled specific examples of research and how the data was used to challenge the structures of racism engrained in schooling.

The youths' decision to submit a proposal for the MLK Student Leadership Conference was a direct example of their desire to share their experiences but to also empower fellow youth to action. When we learned that the conference organizers accepted the proposal, the youth were both pleased but also surprised to learn that their workshop would be a featured session. In the acceptance letter, we were told, "congratulations again on submitting a high quality proposal that was accepted for presentation at the conference. The selection committee liked the Project ERASE proposal so much that it is going to be a mandatory workshop for all Pre-College students as well as open to college students" (Personal communication, 2012). We had imagined a presentation before 20-30 audience members, but we learned that we would need to plan for up to 200 attendees. The larger audience posed a potential challenge for designing an interactive workshop but the youth figured out how to engage a large crowd. The youth were adamant that the workshop needed to be interactive. They talked about how just talking would bore the audience, especially a majority peer group.

Setting up the Investigation

The project started around the narrative told by youth that the school that one attends does not impact opportunities to pursue STEM aspirations. Malcolm argued during one of our first project meetings that success is a matter of "how hard one works". Malcolm attributed unfulfilled STEM aspirations among people of color to "people not working hard enough" while adding that ultimately "people might not be interested in science fields" (Malcolm, Field notes, 2012)

In the same conversation, Caesar stated, “I plan on going to college for engineering” and that where one goes to school does not matter. He added, “High school is high school.”

Justice offered a dissenting opinion that suggested not all schools are the same. Justice described a school attended by her friends as “more advanced” because in conversations comparing what they are learning, her friends said, “Oh, we’ve already done that.”

Based on the youth dialogue, I challenged the group to find out whether the school one attends mattered in terms of opportunities and support to pursue STEM futures. I also invited the group to determine whether self-determination and motivation to realize their future was sufficient to attain STEM aspirations.

In order to provide better context for the events leading up to the conference workshop presentation and the actual presentation, the next section describes the overarching question used by the youth to set up their investigation, information about the conference and getting the proposal accepted, and demographic information for the schools youth included in their investigations.

YPAR Investigations

I share the key YPAR investigations that youth ultimately selected to be part of the presentation. This chapter is organized by the four components of YPAR: (1) Investigation; (2) Planning and Action; and (3) Reflection. Since planning leads to action, the two components are treated together in one section. First, I provide the demographic information for the schools examined by the youth in their comparison investigations. The youth had a shared understanding of the demographic differences between area schools including those that were majority White prior to the project.

Comparison School Profiles

In the quest to find out if the school a student attended mattered, the youth chose to compare schools in the local area. The group decided to compare their school, Murphy High School, with Smithers High School and Lumpkin High School to see whether race mattered with regards to STEM opportunities. Murphy is a majority minority school and Smithers and Lumpkin are majority White schools. The youth participants purposefully selected Smithers and Lumpkin for comparison because their student populations differed demographically with Murphy (Table 5.2).

Murphy is a 9-12 high school located in Great Lakes City with an estimated population of 114,605 (US Census, 2011) persons. In 2011, Murphy High School had 1401 students with a majority minority composition. The demographic breakdown included 47% Black, 27% White, 16% Hispanic, 9% Asian/Pacific Islander and 1% American Indian/Alaskan Native (MDE-a, 2012). Examining the total percentage of student of color at Murphy, 73% of the student body is composed by students of color.

Smithers High School is just over five miles away from Murphy located in an unincorporated area just beyond Great Lakes City and is considered suburban. At Smithers, of the 1390 students in grades 9-12 the demographic breakdown shows 73% White, 13% Asian,/Pacific Islander, 8% Black, 3% Hispanic and 2% reporting two or more races (MDE-a, 2012).

Lumpkin High School is less than five miles from Murphy in a different unincorporated community and is considered suburban. The high school serves grades 10-12 with a separate 9th grade campus. The high school building has 1381 students with a demographic distribution of 71% White, 11% Black, 10% Hispanic, 2% Asian/Pacific Islander, <1% American Indian/Alaskan Native, and 5% reporting two or more races (MDE-a, 2012).

Table 5.2
Demographic Comparison Between Three High Schools

	Murphy High School	Smithers High School	Lumpkin High School
Community	Urban	Suburban	Suburban
Total Student Population (in 2011)	1401 (Grade 9-12)	1390 (Grade 9-12)	1381 (Grade 10-12)
White	27%	73%	71%
Black	47%	8%	11%
Hispanic	16%	3%	10%
Asian/Pacific Islander	9%	13%	2%
American Indian/Alaskan Native	1%	--	<1%
Two or more races	--	2%	5%

The youth shared key investigations completed to answer their guiding question through YPAR with the workshop audience. They elected to share the following investigations: (1) comparison of curriculum guides between schools of different racial composition (Murphy vs. Smithers); (2) visit and observation of science classrooms in a majority White high school (Murphy vs. Lumpkin); and (3) survey of peers at their school (Murphy). Each investigation is shared below with emphasis on youth narratives including direct quotes from the participants to illustrate the impact of their findings. Vignettes of research sessions and quotes from dialogue that transpired during the investigation help to highlight key moments during the research for the youth.

Comparing curriculum guides: Murphy vs. Smithers

> Justice pulled out the pages listing the science classes offered at nearby suburban Smithers High School's curriculum guide while the other youth looked at Murphy High School's science course offerings. Suddenly, Justice exclaimed, "Dang! Did I over count? Oh my gosh! 15 and 16..." as she flipped pages and tallied the number of science options for students at Smithers. (Justice, Field notes, 2012)

The short vignette above captured Justice's surprise at the number of science courses offered at Smithers, a high school barely five miles from the school she attended. The youth had downloaded the curriculum guides for both Murphy and Smithers from each school's web site to look for differences in opportunities. Murphy, the high school Justice and the youth participants attended, offered seven science courses. The state requires three years of science to graduate with a high school diploma. All students must complete biology. Then, students have the option to take chemistry or physics plus one additional science class (MDE-b, 2010). Of the seven courses at Murphy, only three elective science options are available if environmental science and Advanced Placement (AP) environmental science are consider to be one offering. Regarding AP option, Justice added, "You don't get to pick which [AP class to take], [the guidance counselors] put you in it" if the student is deemed capable of advanced level coursework.

Given the new awareness of difference in science class offerings between schools, Malcolm disappointedly said, "People at Murphy won't know as much. Decreases chances [to pursue STEM aspirations]". Deelilah concurred, "They [Smithers] get a better opportunity."

The investigation of the curriculum guides led the youth to the career and technical education section of the respective documents. Again, youth were confronted by inequities between the schools when they noticed that Murphy listed all career tracks available but Smithers did not include a listing of their offerings. In the transcript from the project session, Justice said, "[Murphy] is the simple things. [Smithers is] more advanced and they get to learn more stuff than us. They get a higher education and they get paid more." Justice recognized the different messages from each school toward the preparation of students for future opportunities including earnings potential. She presented a scenario in which a student at Smithers follows an engineering trajectory compared to a student at Murphy pursuing an automotive repair trajectory

and stated, “[engineering is] a higher quality job where you can do more than one thing.” For Justice, the career and technical options prepared students for very specific skills whereas an engineer had flexibility to apply their education to different projects.

As I examined the documents with the youth in our initial research endeavor, I noticed another difference in the two curriculum guides. The difference was a little subtler and not initially apparent to any of us. To help the youth develop skills needed to read text with depth, I asked them to read the career and technical descriptions in both curriculum guides carefully and note the differences. Upon re-examination, the youth picked up on the difference in the language used to describe the career and technical programs.

At Murphy, the curriculum guide billed the career and technical options as "highly competitive, and selection is limited to only the best applicants” (Lansing Everett High School, 2012). Murphy also devoted three and one-half pages to listing and describing the many career and technical programs available. In contrast, the Smithers curriculum guide stated five goals of the program, two of which stood out to the youth. The first goal to stand out stated, “to achieve an employable skill to prepare for the world of work immediately upon graduation from Smithers High School.” The second goal that caught the attention of the youth stated, “to prepare for a more interesting, higher paying, part-time job to offset the cost of a college education” (Okemos High School, 2012).

During the conference workshop, Deelilah pointed out the subtle difference we had discovered to the audience and argued, “To us, [Murphy] makes it seem like the best applicants can get in, you will not be able to go to college and you’ll be working for someone else instead of being the boss of someone.” (Deelilah, Conference Workshop Transcript, 2013)

The discovery that schools do not offer equal opportunities was eye-opening and created awareness that school by itself might not provide equal opportunities and support. Education at Murphy was not presented as a means to uplift students of color into college and STEM careers but rather funnel people of color, people from the lowest classes, and people otherwise marginalized by society into skilled labor while the privileged had greater opportunities. In Deelilah's comments to the workshop audience, she showed awareness that social reproduction was unfolding in her school experience.

Comparing science classroom experiences: Murphy vs. Lumpkin

The discovery the youth had made in comparing the curriculum guides led them to ask if classroom science learning experiences for students in other schools were similar or different to their experiences at Murphy. In a session following the curriculum guide investigation, I wrote in my field notes that the youth wanted to visit the science classrooms at Lumpkin High School to continue their investigation. I asked the youth for other ways to investigate differences in science opportunities between schools. To help the youth expand their ideas of ways to do research, I asked if they wondered what science class looks like in other schools and how we could find out. The youth suggested the best way to investigate science class at another school is to visit in person.

We arranged a visit to Lumpkin and continue the investigation. I contacted two science teachers, Mrs. Newmann and Mr. Bates, whom I know from close connections between Lumpkin and the university. The two teachers are highly regarded veterans and regular collaborators with the university and mentors for student teachers in field placements. Upon explaining the nature of our research, they both invited us to visit their classrooms as guest observers. We visited a biology class taught by Mr. Bates and an upper level botany class taught by Mrs. Newmann.

Biology is a required by the state for high school graduation but botany is offered as an elective science course.

In preparation for the trip to Lumpkin, the youth created an observation protocol that also served as their field notes. The youth developed a set of questions to address whether there was a difference in the way schools supported STEM aspirations. Youth experiences at Murphy shaped the final list of questions for the classroom observation protocol. The questions addressed several points of comparison and ranged from the physical structure of the school building, resources available, teaching methods used by teachers, the behavior of students and student perceptions of Lumpkin. The questions developed by the youth are listed in Table 5.3.

Table 5.3
Science Classroom Observation Protocol Questions

Observation Protocol Question	Youth Reasons for Including Questions
How does the school appear compared to Murphy?	Youth described Murphy as "rusty" and "run down".
How the classroom looks compared to Murphy?	Justice pointed out safety equipment is unnecessary since lab experiences are infrequent at Murphy.
How many students are in the class?	Lil c had class with 45 other students.
How many computers are in each class?	Youth had limited opportunities to use technology in the classroom at Murphy.
How does the teacher approach their answers?	Youth did not feel teachers sufficiently answered their questions leaving them to struggle with assignments or were too pre-occupied with behavior management.
How diverse is the school?	Murphy is a majority minority school. Youth wanted to see the racial composition in relation to opportunities at the schools.
How students are being taught?	Youth at Murphy received instruction that consisted of notes, worksheets and busywork.
Are the teachers actually teaching their students?	Youth were left to "figure it out" or had to come in after school for help.
Looking at the teaching methods?	Youth wanted to know what specific strategies and instructional methods were used at Lumpkin.
How much do the teachers care?	Youth wanted to know if teachers were genuinely concerned for their students.

Table 5.3 (cont'd)

How much enforcement does the teacher have? Does the teacher have control?	Youth complained that a few troublemaking students at Murphy took away the attention of the teacher from students who wanted to learn.
How do the student act in the classroom? Behavior of the students. Do the kids listen?	Youth indicated some peers detracted from the learning opportunities at Murphy.
Are the students engaged in the lesson?	For the youth, student engagement was indicative of the teaching in a classroom.
What do students have to say about their school?	Youth wanted to hear directly from Lumpkin students.

General Observations of Lumpkin. Before we set foot in a classroom at Lumpkin, the youth already started noticing differences. I wrote in my field notes, "as we pulled into the Lumpkin parking lot, [the youth] started pointing out the differences right away. The first thing they noticed was the number of cars in the student parking lot. They also commented on all the clearly marked signage in the lot to help you get around" (Lumpkin Field Trip, 2012). Lil c wrote in her field notes, "Lumpkin looks more like a business than a high school" and "The school name is actually visible from the outside." When we moved into the main area that doubles as the cafeteria, the group noticed the trophy cases filled with various awards. As we walked, Lil c was noticing the carpeted hallways. (Lil c, Lumpkin field notes, 2012)

In contrast, Caesar had previously asked me, "Have you been inside rusty Murphy?! I'm surprised it's still opened up" (Field notes, 2012). Rusty wasn't necessarily a literal translation but Caesar used the term to describe the overall age and rundown physical structures of the old school building. Later on during the project, I wrote in my field notes that as I walked down the halls of Murphy with Justice she pointed out how "run down" their building was compared to Lumpkin (Survey Day field notes, 2013). She pointed out the uneven ceiling tiles in the hallway and an unrepaired hole in an exterior window along the hallway (Figure 5.2 and 5.3). For the youth, the differences were not trivial as they felt that the physical learning environment contributed to student success. Modern facilities and a well-kept campus added to the

"professional business" atmosphere and suggested the availability of resources to support student success.

Figure 5.1. Photograph: Uneven ceiling tiles at Murphy.

Figure 5.2. Photograph: Hole in window at Murphy.

Lil c noticed that the computers in the Lumpkin library had more recent operating software installed suggesting better technology resources were available. A Lumpkin student confirmed Lil c's observation of technology during the classroom visits. Lil c wrote, "One student said they have advanced technology" (Lil c, Lumpkin field notes, 2012).

Youth noticed where people of color were represented at Lumpkin. We noticed the sports team photos/posters in the main office windows. Justice commented that most of the black kids were only represented on teams where you might expect to see them (basketball and football) (Lumpkin Field Trip, 2012). Justice also perused the photos of the faculty at the school and noted, "There are three Black teachers." Given the interest of the project in race, the youth recognized that Lumpkin was a majority White school.

Science Classroom Atmosphere at Lumpkin. The youth noticed differences in the science classrooms at Lumpkin compared to Murphy. Class size stood out to the youth. Lil c counted the number of students in the class at Lumpkin and recorded in her field notes, "Biology – Bates class – 18 kids compared to our 45" (Lil c, Lumpkin field notes, 2012). Justice added in her field notes, "less students easier to learn" (Justice, Lumpkin field notes, 2012). The youth later learned from Mrs. Neumann that the class sizes are capped at 28 students (Interview with Mrs. Neumann, 2012). In addition to noticing the smaller class sizes also seen in Mrs. Neumann's classroom, the youth saw the classroom space as newer and better than the rooms they were accustomed to at Murphy.

The youth also observed how the classroom space at Lumpkin reflected the subject being taught. Mr. Bates had several animals including fish and reptiles in his classroom. Justice wrote, "Lumpkin has animals in class" and Lil c added in her notes that having animals served "to display the subject more". That is, the students had live specimens to examine as they learned in biology class.

The teacher-student relationship often set the tone for the classroom space at Murphy and led to the youth to explore the dynamic at Lumpkin. Observations of the teacher-student relationship at Lumpkin revealed an overall positive atmosphere built on mutual respect. The teacher-student relationship allowed for a space conducive to learning free of power struggles paving the way for order in the classroom. Justice wrote about the way students responded to the teacher as well as our group and noted, "They're well mannered and welcoming and open". Lil c added, "The students are quiet and pay attention to the teacher". Caesar also commented on the respect shown by students and only noted minor concerns, "Yes they do [listen]. They are respectful but a little problems here and there."

For the youth, the teachers at Lumpkin were strategically controlling the classroom environment to foster learning and keep students focused. Lil c noted how Mrs. Neumann strategically placed her projector and screen in the room to minimize distractions for students. She wrote, "one teacher had the projector screen right in front of the door so that the students can't look in the hallway and lose focus" (Lil c, Lumpkin field notes, 2012).

The youth asked the students at Lumpkin for their perceptions of the school and whether they liked their school. Justice wrote that according to Lumpkin students "[School is] good and interesting" (Justice, Lumpkin field notes, 2012). Therefore, the youth surmised that Lumpkin students were less inclined to skip class because class was "interesting" whereas at Murphy students didn't want to be in class. Earlier, Caesar and Justice both independently wrote in their field notes about Lumpkin stating, "Halls are empty." The youth talked about how it was hard to skip class at Lumpkin and was confirmed by a student told Lil c "It's hard to skip class". I asked why anyone would skip and Lil c mentioned because students don't want to be in class at Murphy (Lumpkin Field Trip, 2012). The absence of loitering students in the hallways at Lumpkin suggested that the school atmosphere supported learning.

Classroom Instruction. As described in the previous chapter in the youth science narratives, science experiences at Murphy left the youth seeking better instructional practice and interactions with their teachers. The youth were very interested to see whether students at Lumpkin had similar relationships with their teachers. The following paragraphs illustrate how the youth used research tools in two science classrooms at Lumpkin. The youth employed observation skills and interview skills to gather data. The youth were also participant observers in the science classrooms as they interacted with Lumpkin students and worked with them on two activities.

The youth observed labs and activities in both classrooms they visited. We started classroom observations in a biology classroom. Mr. Bates introduced the youth at the beginning of class to the Lumpkin students as guests and biology experts from Murphy. Mr. Bates followed with a set of instructions for a group activity. Each group was to create a food web using the cards showing energy relationships between organisms. The students were provided with a stack of photo cards of various living organisms from an ecosystem with information about the species on the back. The students used chalk to draw in the links between species directly on the large black lab tables. The youth became participant observers as they dispersed and moved between the groups of Lumpkin students. The students had varied degrees of success determining how to draw their food web and identifying relationships among the species.

In Mrs. Neumann's botany class, I wrote in my field notes, "The group stayed for the botany class where the students were finishing a wood activity. They had various blocks/samples and informational sheets. Our kids received the worksheets and they started filling them out along with the Lumpkin students. I wonder if they felt obligated or maybe out to prove that they could do the work. The latter part of the class had students working on their fast plants lab where the groups each manipulated a different variables/conditions to see how well they'd grow."

The class wrapped up an activity exploring the characteristics of different types of trees (wood). The youth participated with the Lumpkin students as they exchanged samples and recorded their observations on data sheets. In the latter half of the botany class, the Lumpkin students gathered data for their plant growth experiment. They had set up experimental conditions they were allowed to define to learn about the variables of plant growth. Each group had altered conditions such as amount of light, type of light, amount of water, and other variables to measure the effects on the plants.

The youth were attentive to the Lumpkin teachers' actions having countless hours of observations back at Murphy with which to compare. The youth appreciated the instruction they observed at Lumpkin as Justice added "The teachers value education." Lil c was very complimentary in her description of the two teachers we observed. In her field notes, she wrote, "[Mr. Bates] gives clear instructions on all the project and then sends [the students] to work. Mrs. Neumann makes sure the class is quiet before she starts to talk". Justice made note of how teachers responded to student questions and wrote that they "Listen and give a good response. Very helpful!" (Lil c, Lumpkin field notes, 2012). This was in direct contrast to the instruction they youth reported at Murphy. Caesar previously stated, "[Teachers] tell us we can't do it" with regards to being successful science learners. Justice added, "I think it's the way teachers give up on us" (Justice, Science Interview, 2012).

The youth also used a more critical eye toward the teaching methods on display and whether they were effective due to the confusion some Lumpkin students expressed during the food web activity. Justice wrote in her field notes that the teachers at Lumpkin were teaching "but not enough instruction" (Justice, Lumpkin field notes, 2012). As Lil c joined a group of Lumpkin students working on a food web activity in biology, she recorded in her field notes, "[Students are] somewhat [engaged] but some students weren't sure on what they were supposed to be doing" (Lil c, Lumpkin field notes, 2012). Caesar was the most critical and wrote that the teaching was "Not really good" (Caesar, Lumpkin field notes, 2012). The youth were less accustomed to the open-ended approach to science instruction that they observed at Lumpkin. Science had been experienced by the youth at Murphy primarily through note-taking, worksheets, and tests. And often, as Caesar noted, teachers at Murphy simply handed out assignments and left it to students to "figure out" (Caesar, Science Interview, 2012). The instructional approach

demonstrated at Lumpkin created uncertainty among the youth leading them to wonder whether teaching was taking place. The open-ended approach to the activities they observed presented a clash with their experiences of finding the correct answer for worksheets and being told what to know during note-taking.

For the youth, the frequency of hands-on activities and labs at Lumpkin in just the two classrooms was different from what they observed at Murphy. In Mrs. Neumann's room, the students transitioned between two active tasks in one class period. Before the students arrived, Mr. Bates explained the lesson plan for the biology class to us. Later, the youth asked Mr. Bates about the frequency of hands-on learning in his classroom. I wrote in my field notes that "toward the end of Mr. Hodges class, the youth got to ask him a few questions. One of the questions the youth asked was how frequently did he do labs with his classes. He told our group that he tries to include 4-5 labs or activities a week. He reiterated that activities weren't necessarily labs, but he did try to get his classes working on problems in groups on a regular basis" (Lumpkin field notes, 2012).

The youth also interviewed Mrs. Neumann who expressed some shock to learn how large classes were at Murphy and that they still occasionally did lab activities. In my field notes, I wrote, "We found out classes are capped at 28 students at Lumpkin. Lil c talked about the 46 students in her chemistry class to which Mrs. Neumann asked whether they get to do labs. Lil c said that they actually do get to do labs and that was a bit of a surprise for Mrs. Neumann."

After observing two classes, we thanked the teachers and said our goodbyes. As we walked down the hallway, I overheard a conversation between two Lumpkin students. One student had been in Mr. Bates' class and said to his friend, "we had kids from Murphy helping us in class today". The hall was crowded during a class change so I didn't get to ask whether the youth

overheard the same comment. Once we were in an open area, I asked but none of them seemed to make much of the comment.

Survey of Murphy Students

The Lumpkin students' satisfaction with their school reinforced the youths' growing sense of disparity between Murphy and other schools. They conducted a survey at Murphy that confirmed their peers shared similar displeasure with the academic opportunities.

In the youth authored script for a conference presentation for academic science education researchers, they wrote about their survey:

> "We did a survey with students at our school to get more data. We had students take the survey using iPads. We wrote questions about how much support students get at school to pursue their dreams. We asked about relationships with teachers. We asked about how the school handles discipline. We also asked if students like the food. Most students didn't like the food in our cafeteria. Why is that important? Students need to be able to eat good food to have energy so that they can learn in school. That's why we wanted to teach younger kids about food and nutrition. We will share more about that later. We also found that many students don't think our teachers care enough about our grades. But a good thing is that most students said their teachers are available after school. Students also want our teachers to do a better job of answering our questions. Here is a chart showing some of our results" (Youth Virtual Presentation for NARST, 2013).

The youth explained why they wanted to survey their peers at Murphy and identified the types of questions they asked. They presented data from their survey on students' preferences for staying at Murphy or transferring to a different school. A follow up question asked survey respondents to give a reason for their preferences (Table 5.4).

Table 5.4
Murphy Student Reasons for School Preference

Stay at Murphy	Go to Another School
• I'm just comfortable in it. It's Murph nation • Because all my friends are here • Because its where my family attended	• Because they have more money and better supplies • Better school • Better academics and sports

The survey allowed youth to use another tool of research and to use the data to generate a set of findings. The youth found that slightly over half of the Murphy students surveyed preferred to attend a different school. The development of the youths' analysis skills enabled them to notice a distinct difference in the reasons provided for school preference between the students who wanted to leave and the students who wanted to stay. The students that preferred to be at another school included resources, academics and extracurricular activities as reasons for wanting to depart. Whereas, the students that preferred to stay cited familiarity and belonging in the community. They desired to be in the proximity of friends and attend the school with which their family had a history. This revealed the tension felt by students of wanting greater support and learning opportunities but having to leave the home community in order to pursue one's aspirations. For the youth, transforming opportunities within the community was central to their YPAR findings and actions as described in the next chapter.

Food and nutrition, while not overtly connected to STEM aspirations, featured regularly in the concerns of youth. Caesar included in his field notes from the visit to Lumpkin that the school had "more lunch lines". Lil c wrote about the Lumpkin dining area describing it as a "nice lunch room". Students told her that Lumpkin had "better food than most schools" (field notes). The youth used their concern for student nutrition and included a survey question about food at Murphy. Of the students to respond to the survey question on the quality of school lunches at Murphy (n=25), 21 students indicated they were either horrible or bad. Three students indicated

they did not eat lunch at school, and only one student marked that lunches were good.

For the youth, the low quality of the school lunches and lack of choices at Murphy as compared to Lumpkin negatively contributed to the ability of students to be nourished in order to learn during school. The youth were inspired by the concern with food and nutrition and designed a teaching unit for their younger peers at the youth center as one example of the action taken in YPAR. The teaching unit is described fully in the next chapter.

The survey touched on a variety of topics but I focused on questions regarding whether students desired to be at Murphy or attend a different school and how the students felt about lunch options at the school. I elected to highlight the data youth found and used from these two questions to build the link to the action in support of the pursuit of STEM aspirations. The survey instrument included questions about academic support available from the school, teachers and guidance counselors. Other questions probed their peers for responses to student behavior and disciplinary policies and actions of the school. The questions chosen for inclusion thus represent core areas of concern the youth participants had about their school and carry a very deep connection to their own experiences. The youth wanted to know whether their peers shared the sentiments or had other ideas about the issues so that they could use their survey findings to inform their plans for action.

YPAR Planning and Action

The planning and action are described together given that developing strategies to take action are closely connected. We were tasked with conducting a workshop for up to 200 high school peers expected to be in attendance at the Martin Luther King Jr. Student Leadership Conference. When the youth originally submitted their conference proposal to lead an interactive workshop, they started planning for 20-30 attendees. The unexpected increase in the audience

size prompted the youth to imagine how to conduct an interactive workshop with such a large group of peers. We compiled an inventory of completed YPAR investigations and actions to get us started. Then, we focused on the workshop format.

In my field notes, I wrote, "I started by asking them to help me recall all the things we've done thus far. I figured making this list will help stir up some ideas on what we might want to present. Given that we are to do a workshop, I was wondering how they would help inform the audience on what they can do in their own communities. We created a list of the different activities we've engaged." Next, I pushed them for ideas of how they wanted to format the session. I wasn't getting much input so I made a suggestion that we have copies of the curriculum guide pages from two different schools and have the attendees identify differences or have sticky note pads for people to write things on and post them on the walls. They didn't go for either idea. They weren't convinced that having copies of curriculum guides would be engaging enough. I'm equally stumped by preparing a workshop for the estimated audience sizes (field notes).

As a group, we were perplexed with scaling up our workshop for the large audience. I tried to offer suggestions to initiate a conversation and stimulate new ideas. The group quickly rejected my ideas as too boring for a workshop. We found ourselves stuck unable to take the next step in planning the conference presentation. And then Lil c asked for more information about what the conference would entail. I was very shortsighted to assume the youth were familiar with the context of the conference.

Lil c sparked an important conversation and allowed me to provide better understanding for what we were preparing to do and the space we would be in. In my field notes, I wrote, 'I realized then that perhaps they weren't familiar with this type of workshop. So I explained what

to expect and that students were expected from across the state including from Detroit. They asked about attire and joked about wearing things that probably wouldn't be ideal for the setting. But in the end, I think they decided that they should wear clothes appropriate for presenting before an audience. We struggled through the time. Partly complicated by lack of familiarity with conferences and/or putting together a workshop." Armed with a better sense of the expectations for the conference workshop, the youth were able to provide ideas and we moved forward with planning.

The Workshop Presentation

The youth decided to format at least part of the workshop session "more like a game show" (field notes). They made certain that the workshop invited attendees to be active participants rather than a passive audience. Leading a workshop for a peer audience was an important opportunity to share their work to expose the how youth of color are marginalized in school and to inspire peers to become researchers in their schools and neighborhoods. Thus, having the peer audience actively experience the tools of YPAR was critical for attendees to return home and to be equipped to engage in research for change.

The following paragraphs describe the workshop presentation at the student leadership conference as shaped by the youths' desire to lead an interactive session. The youth organized the presentation around the four steps of YPAR. First, they introduced the project and their research question. Second, they provided examples of the YPAR investigations they completed. Third, the youth shared examples of actions taken and actions planned. Fourth, they addressed initial reflections and the questions they would use to look back on the project at the end. The workshop emphasized the investigation piece in order to provide the audience with tangible strategies for research at their sites.

The youth presented their investigation of school curriculum guides in game show format. They showed excerpts from the curriculum guides and invited the audience to guess to which school it belonged. They described Murphy and Smithers including the demographic composition for each school. Murphy was referred to as "our school" and meant literally the school the youth attended and representatively of schools with a majority minority population given that the audience was composed of youth of color attending similar schools. Smithers was referred to as "their school" symbolizing the majority white student population. For each excerpt revealed on the big screen at the front of the room, the audience participated by show of hands indicating whether they thought the excerpt was for our school or their school. The format allowed the youth to show how one can easily find information to reveal whether our school and their school offered the same opportunities. Furthermore, by exposing the difference wording can make, the youth provided a concrete example of how students of color are prepared for certain educational outcomes and career trajectories.

The youth presented surveys as a research tool to the large audience by engaging them in responding to a survey. The goal was to show how quickly a survey can generate useful data about the school. The audience responded to a set of questions by writing their answers on sticky note paper and posted their responses on walls around the room. The audience was instructed to identify what was good at their school and what needed to be improved about their school. Opposite walls were labeled prior to the workshop with the main categories of "good" and "needs to be improved". The two sides included four subcategories: (1) Academics; (2) Teachers; (3) Safety/Rules; and (3) Other. After audience members wrote one good and one needs improvement sticky note, they posted their responses on the walls under the corresponding headings. The number of sticky notes under each subheading provided instant visual

representation of the responses. The youth invited the audience to identify trends they noticed in the data and helped the audience quickly identify the main things that are considered good in the school and also what needs improvement. They circulated the room and shared out examples of good and needs improvement responses with the audience. In a quick and effective demonstration of YPAR skills, the youth displayed the power of survey data by having the audience participate in the survey and to do a simply analysis of the data.

For the action component of the workshop, the youth shared their self-authored video as an example of how they wanted to support peers toward college and career opportunities. Recognizing the lack of a college-oriented culture at their school, the youth set out to inspire peers to work toward college and show the benefits of going to college. The youth created a public service announcement (PSA) video that was light and humorous but still delivered the important message that going to college can lead to better career opportunities and financial stability. In the video, Lil c played the role of Sarah, a young person struggling to keep up financially with her bills without a college education. Sarah decided to go to college and has a meeting with a professor. Sarah was inspired to get her college degree after she found out that the professor earned a livable salary. The professor, played by Justice, told Sarah about the benefits of school and during the conversation playfully flashed a large stack of oversized paper money. Sarah's jaw dropped at the sight of the money in what was meant to be a funny moment but underscored by the reality of needing a higher degree to earn a reasonable salary. The issue of educational attainment and earnings was an everyday concern for the youth that was also featured in a radio PSA.

The youth accomplished two things by showing their video to the attendees. First, the video was an example of how youth were communicating with their peers to positively impact

the desire to continue on to college. Second, the audience provided an opportunity to expand the number of viewers that are potentially influenced by the video. In addition, the youth shared instructions for how to link to the project Facebook and Twitter presence where they could find the video and other content. Thus, the workshop provided an example of how social media was being used by the youth and encouraged the audience to maintain college aspirations.

YPAR Reflection

The reflection section examines how youth described the outcomes their participation in YPAR with emphasis on their conference workshop presentation. Each of the three presenters commented on the workshop afterwards.

"We accomplished a lot!" (Justice, Field notes, 2013)

As we left the conference, Justice made the comment reflecting on the workshop session. But her comment could be extended to the work throughout the YPAR project. The youth conducted several investigations and took action toward social justice in multiple ways over the course of a full year. Preparation for the workshop forced us to take stock of all the YPAR work completed and ongoing. The youth were able to share their gained experiences and knowledge with research and taking action with their peers in the presentation.

"We have a voice." (Lil c, Group Interview, 2013)

Lil c's quote captured sense among the youth following the workshop that they can make a difference and that they can speak back and out against inequities. The new confidence was in direct contrast to earlier conversations where youth felt no one listened particularly to youth of color. Caesar had commented on the depiction of the people of color in the cinematic adaptation of the book *The Help*, a story about a White author that chronicles the hardships of African-American maids during the civil rights movement (IMDB, 2013). Speaking to the fact that a

White author brings out the voices of the maids, Caesar poignantly commented that the story communicated “Black people can’t do it for themselves”. He added, “You hear so many times that you can’t do something, you start to believe it is true” (Caesar, Field notes, 2012).

“Feels like we did something.” (Deelilah, Group Interview, 2013)

Following the workshop, the youth took on a new perspective as individuals capable of working toward more equitable opportunities to pursue STEM aspirations but also apply their experiences broadly in their daily lives wherever and whenever oppression is found. The audience response provided the youth with an important source of validation. If their peers received the workshop message and were inspired to examine the conditions that exist in their lives, the youth had successfully made an impact. The following quote came from an audience member during the question and answer portion that followed the presentation. After the youth had fielded and answered audience posed questions, Justice flipped roles and asked the audience what they had learned. An audience member spoke up and said the following:

> “One thing I learned, even though we are kids, and we are teenagers and people do not listen to us, that we can still make a change in our communities. It starts with making a change in ourselves and making a change in other people and we can still take part and help bring change and have the dream that we need to have” (Peer audience member, Presentation Transcript, 2013).

The peer validation had a reciprocal effect with regards to inspiration. The youth wanted to continue the work they had started and push for more action. Lil c went home from the conference with her mother who had attended the conference and I provided a ride home for Justice and Deelilah. As I dropped off Justice, she said with renewed energy to continue our YPAR work, “I’ll see you Wednesday!” (Field notes, 2013).

Benefits of YPAR

While YPAR seeks to fight social inequities and bring forth change, the direct outcomes for the youth are equally transformative. This closing section of the chapter recaps the ways YPAR conferred three major benefits to the participants: (1) youth gained scientific research tools and skills to investigate race and racism in their science learning experiences; (2) the youth created opportunities to have voice in new venues and reach new audiences; and (3) YPAR elevated the awareness of how racism is embedded in society.

Research Tools and Skills for Investigating Race and Racism in STEM Experiences

Youth gained access to and learned how to use the tools of scientific research for developing awareness of and understanding of how race and racism are systematically used to marginalize students of color along STEM trajectories. In investigating the role of racism in school science, the youth developed different tools and strategies for gathering evidence in seeking answers, which included: (1) identifying sources of data; (2) selecting and developing research instruments; (3) using data analysis tools; and (4) taking on different roles as researchers. And they also learned to use their findings to challenge inequities and plan action.

Identifying sources of data. The youth quickly identified their lived experiences as the first source of data. In the context of the YPAR investigation, the youth drew from their own experiences as students with STEM aspirations in a majority minority school. Engaging in research legitimized their experiences in school science and with racism. The youth realized that they would need to support their narratives with additional sources of data to be taken seriously in a push for social change. They identified potential participants for their research including peers, school personnel, and the community members at-large. Unable to invite everyone to participate, youth refined their attention to participants that could speak to the science

experiences in school. In two separate investigations, youth surveyed their peers and interviewed college students about their high school experiences.

The youth expanded their potential sources of data beyond participants. They focused on the Internet and specifically the Murphy High School website. The youth periodically visited the school website to monitor their grades through the online portal so they had some familiarity with the contents. Recognizing the amount of information available on the school website, they opened their Internet searches to include other school websites leading to the comparison of the downloadable curriculum guides for Murphy and Smithers.

The research questions about STEM opportunities at different schools led the youth to consider the school as a research site. The youth asked whether we could observe science classrooms in another school to gather data for comparison. For the youth, observations at another school provided a comparison set to be analyzed with the self-reported data from their school experiences at Murphy.

Selecting and developing research instruments. After identifying potential data sources, the youth contemplated how to elicit data from the people and places they considered including in their investigation. The Internet was the most apparent for the youth. They decided that they would download documents that were relevant to their work from the school websites. The curriculum guides for Murphy and Smithers were downloaded for the investigation.

The youth suggested interviews as a way to get data from people. For the first interviews the group conducted, they wanted to go and simply invite participants and start asking questions about the topic of study. I wrote in my field notes that I suggested interviewing required more thought into the type of data the youth hoped to gather and how they would get the data. I pointed out that it is possible to forget a question or two if we didn't pre-plan at least some of the

questions. The youth wrote questions to support the goals of the investigation and understood the advantage of a structured interview to insure all questions are asked. But during the actual interview, I noticed Justice was in particular very good at using a semi-structured approach by asking follow up questions and additional questions that were not pre-determined.

When the youth suggested inviting their peers to participate, they quickly realized the challenge of interviewing several peers to get a larger sample size. They decided to use a survey instrument instead. The youth designed their survey using Google Docs to simplify data collection. Google Docs automatically placed survey responses into a spreadsheet eliminating the need to manually input data from paper surveys. I did not want to stifle the work of the youth so I stepped back and allowed them to add questions they wanted to ask. Once they finished writing questions, I engaged the group and provided steps to review the questions they generated. First, I asked the group to read each question and remove any repetitive questions. Second, I asked the youth to group questions by topic or themes and determine whether they needed to be in a particular order. Upon review, the youth realized that they could group questions by academic concerns, support from the school, and school rules and policies. Finally, the youth explored the different types of survey questions including Likert, multiple choice and open-response. The youth wanted the survey to be easy for peers to take so they limited open-response questions that required typing to those that were best answered in the words of the participant. For example, the youth asked for a typed response to the question asking their peers which school rule they would like to see changed. An open-response allowed participants to choose freely from among the rules prompting a range of answers. For a question on the frequency of meetings with guidance counselors, the youth established ranges and asked participants to indicate 0 times, 1-3 times, 4-5 times, or 6 or more times in a school year. They drew from experiences within the group to

determine the break points for the choices they offered. No meeting in an entire year was determined to be problematic and unusual. The group consensus was that 1-3 times a year was standard. They recognized that some students met more often so they included a 4-5 times option. And 6 or more was an extreme. By carefully vetting the questions and answer choices, the youth refined their survey instrument. They also developed skills for producing survey questions that aligned with research goals.

The decision to visit another school created the opportunity for youth to use observational skills as a tool for data collection. In order to document their observation data, the youth used field notes to record what they noticed. As shown above, the youth designed a set of questions to guide their observations. A process similar to the one used to select and refine questions for the survey was used for the observation protocol. On the day of the observations, the youth carried with them the printed observation protocol to the keep their notes during our visit to Lumpkin.

Using data analysis tools. YPAR provided youth with opportunities to learn and use different data analysis tools. Comparative approaches were most frequently used with the various pieces of data. This aligned with the focus of the YPAR investigation on whether opportunities to pursue STEM trajectories varied between different high schools. During the analysis process, I did not explicitly name the methods for the youth but rather focused on engaging them in the process of looking at data.

In analyzing the curriculum guides, the youth applied quantitative and qualitative analysis techniques. The comparison of the science course offerings relied on the youth counting the total number of options at each school. Uncovering the different in language in the career and technical section of the two curriculum guides required a qualitative analysis. The youth conducted a close reading through an analytic lens that seeks to expose racial inequities. That is,

the close read provided youth the opportunity to analyze data by drawing from a critical perspective that recognized racism as a pervasive issue in education.

The interviews led by youth were often used to provide supporting statements when paired with other data. For example, Mr. Bates at Lumpkin stated that he tried to incorporate 4-5 activities throughout the week in his science classes. The youth paired Mr. Bates comments with their observations of the frequency of activities observed in two classes at Lumpkin. Given that the youth only observed one day at Lumpkin, the interview helped the youth to show greater frequency of labs and activities over their experiences at Murphy.

The survey data presented youth with opportunities to use tools to visually represent their data. Once the youth prepared the graphs, they were interpreted to make sense of survey responses. For example, in the graphs presented earlier in this chapter, the peer response indicated an overwhelming consensus that school lunches were horrible. The youth were able to use survey data to produce compelling evidence to support their assertion that school lunches were substandard.

The analysis of observation field notes allowed youth to build interrater reliability skills. While the youth did not calculate a score for interrater reliability, the youth engaged in the practice of conversing with colleagues to build consensus on the science opportunities and teaching practices observed at Lumpkin. The youth also received feedback on their observation skills when they uncovered any discrepancies within the group.

Taking on different roles as researchers. The youth found themselves assuming several different roles during the research process. The youth were simultaneously leading a research project while participating in the project being reported here. Within the YPAR investigation, the youth moved between different roles.

In the context of this study, youth were participants and youth researchers. As participants, I asked the youth to consent to allowing me to collect data on their experiences with YPAR. As youth researchers, I scaffold their experiences with YPAR and supporting their inquiry by providing an orientation to research.

Within the YPAR investigation, the youth were the lead researchers and participant observers. They were also activists for social justice. As lead researchers, the youth designed the investigations starting with the problem to investigate and selecting the tools to gather data followed by analysis. The youth took on a participant observer role at Lumpkin when they worked with the students on the group activities. By working alongside the Lumpkin students, the youth were also students actively participating in the class. Simultaneously, the youth were observers taking notes on various activities taking place around them. As activists, the youth used their voice and research evidence to advocate for learners of color and fought inequity.

New Spaces and New Audiences for Youth Voice

YPAR provided the means to disrupt traditionally exclusionary spaces for youth voice. According to the participants, youth voice rarely gained traction with adults and was often debased as nothing more than ill-formed complaints. YPAR enabled youth to expose systemic marginalization using claims backed by evidence from legitimate research. Supported by research, youth authored spaces for their voices to be heard by different audience across several venues. By authoring spaces for youth voice I mean that their audience took up the youth narratives about school experiences. For example, youth shared survey data showing that slightly over half of the respondents from the school wanted to attend a different school. The data affirmed the youth claim that students were dissatisfied just as they were at the opportunities at the school.

The new spaces authored included the MLK Student Leadership Conference and the academic research conference. The youth presented before a peer audience at the MLK Student Leadership Conference and shared YPAR methodology with hopes of encouraging others to author spaces to be heard. The conference audience made up of peers represented a new space for the youth who presented a workshop for the first time. The venue traditionally welcomed youth presenters but for the trio of participants, this was their first conference presentation. The virtual presentation for the science education research conference was also a new space for youth to have their voices heard. Youth presenters are seldom included in this conference but they were able to have their experiences taken up by academic researchers. Therefore, for voice to be heard, there must be a receptive audience.

Authoring new spaces comes with challenges as the youth discovered. The youth found themselves in uncharted public spaces in front of new audiences that caused nervousness. After the MLK presentation, Lil c's mother and younger sister joined us for a debriefing of the presentation. Justice talked about overcoming nervousness. The following excerpt comes from a transcription of the conversation.

> Justice: You know, that's what [the teen director] was saying is my biggest fear [public speaking]. Especially the Youth of the Year thing that I did. That was a big problem, too.
>
> Lil c's mother: You didn't seem nervous at all. (group laughter)
>
> Justice: Lil c was a good partner. She was like 'you guys just calm down. We got this. We got it'. And Deelilah hittin' me, telling me to stop tapping. Well, hopefully we can just do better next time. I think we did really good. I can't wait to do

> something different. You know I was really scared about coming [to the conference].

Justice overcame her fear of public speaking sought new spaces to shared the work of the group. I had whether they wanted to apply to present at a different conference and unanimously they said yes.

Authoring new spaces for presenting their research seemed to inspire youth to see possibilities for having voice with new audiences. They sought new spaces and audiences willing to hear the concerns for equitable opportunities for youth of color to pursue STEM pathways. For example, after the MLK Conference, the youth presented virtually during a session at a major science education research conference. The youth authored the new space in three ways. First, the youth interrupted the academic conference space by being present, albeit virtually. Second, the youth assumed the roles of researchers and experts before conference attendees from higher education who themselves are highly degreed researchers. The youth leveraged their lived experiences as science learners of color next to the credentials of the audience members at the conference. Third, the youth engaged with the audience in the question and answer session following the presentation opening a new space for dialogue. While academic researchers do interact with youth in their work, the question and answer was different in that typical roles were flipped with the scholars asking youth about their research. The youth gained confidence from the presentation and have been accepted to present at a third conference for community-based activists.

Elevated Awareness of Racism in Society

The YPAR project heightened youths' awareness of racism in society. The youth were critical thinkers when we started the project but through participation were able to refine their

ability to read occurrences of racial oppression. Armed with research tools, youth recognized the subtle ways racism was enacted with direct impact on their learning opportunities. For example, being able to read the language in the Murphy and Smithers curriculum guides raised a new level of awareness that the two schools positioned the career and technical education programs and opportunities in very different ways as described earlier. When connected to racial composition of the two schools, the youth recognized how racism was being carried out hidden in plain sight.

The difference between the curriculum guides is part of a larger example of systemic racism that continues to remove students of color from college and STEM pathways. Justice noticed that Smithers pushes students toward college and Murphy pushes students toward skilled labor careers via the career and technical programs. Lil c and Malcolm were told they did not need to take math or science in their senior year of high school. Deelilah claimed to be in the same math class two years in a row because the high school said her middle school math "didn't count". Collectively, the youth recognized a pattern of low expectations at Murphy whereas suburban schools continued to send students to college. I asked Lil c to name one graduate from Murphy in the previous year besides Malcolm that was currently attending college. She was unable to name a single student that went on to college. The low expectations are a form of racism that oppresses students of color by denying opportunities to take rigorous courses and seek higher career aspirations.

Connecting to CRT

In Chapter 5, the recognition of and the naming of racism in all of the spaces that it occurred was most prominent. The other tenets are not diminished by this focus as the chapter also detailed stories that are counternarratives and show the youth pushing toward social justice. But, in the work of CRT, racism must be made explicit and exposed in order to fight the

structures that impose the oppressive conditions. Throughout the research investigations of the project, the youth uncovered ways racism manifests itself in (the lack of) science learning opportunities.

As we saw, the youth of color for whom these marginalized experiences are a lived, daily reality, intuitively knew differences existed but often did not explicitly recognize the forces conspiring against their STEM aspirations. While some experiences are more explicit and tangible such as limited learning opportunities in class, others are more subtle or hidden from view. The youth had awareness that their opportunities were not the same as those of students at other schools, YPAR enabled youth to name the places where inequity was being carried out. Youth exposed racism in the science classroom, school curriculum and course offerings, and school support structures. In order to fully recognize the way race mattered despite already harboring dissatisfaction with aspects of their schooling, the youth had to compare the conditions at Murphy with majority White schools. A comparative look, whether at curriculum guides or actual classrooms, confirmed the difference in experiences for youth of color. For example, when Justice realized how many more science courses were offered at Smithers, she and the youth now had evidence to support their assertion that their opportunities were not the same at Murphy as for students at a majority White school.

Documenting racism in STEM opportunities created the foundation for the youth to carryout goals to transform the oppressive structures compromising their STEM trajectories. Likewise, youth are also putting their findings into the hands of school officials and science educators through their presentations in hopes of gaining the support of those in position to advocate for them. But, the institutional narratives discussed in Chapter 4 pose a significant challenge to the youth efforts when school leaders can simply point to budget cuts for unequal

opportunities and use deficit perspectives to justify limited science learning opportunities. Arguing that schools serving majority minority student populations lack the resources to add science courses or provide laboratory equipment sidesteps the issue of race and racism. This insistence on the disparities as a resources issue circumvents needed dialogue and policy changes that acknowledge the continued racial oppression of students of color. If youth of color are denied their STEM aspirations in high school through systemic racism, there should not be any surprise at the continued decline in the number people of color entering the STEM workforce.

The youth were also cognizant of the socioeconomic and class based factors contributing to difference in school opportunities. They also recognized that youth of color were disproportionately marginalized through the intersectionality of social forces that create difference among people. Thus, naming racism was the most salient tenet of CRT in this chapter.

Looking Forward

This chapter examined the investigations undertaken through YPAR and the benefits for the youth. In the next chapter, the focus shifts to the planning and action taken by youth to transform the STEM trajectories for younger peers at the youth center. The chapter specifically focuses on a teaching unit for the younger peers on food and nutrition and looks closely at the ways research informed youth decisions in the planning and implementation of the lessons.

CHAPTER 6

TEACHING SCIENCE AS YPAR

One of the major actions taken by the youth during YPAR was to teach a science unit on food and nutrition to a group of middle grades youth at the local community center. For clarity, I will use the term *youth* to continue to refer to the YPAR participants and participants in this project. I will use the term *younger peers* to refer to the middle grades youth that were the students for the teaching unit. The decision to teach a science unit was in response to the youths' experiences in school science and the disparities in school science learning experiences the exposed during their research investigations. The youths' experiences in school science and YPAR led the youth to conclude that students of color do not receive the same opportunities for science learning that support STEM aspirations. Furthermore, for the youth participants, food and nutrition was a central issue in the schools and more broadly the community. They noted on several occasions that the food options at their school were limited as well as in their homes.

In this chapter, I describe the planning process of the youth that ultimately led to the curriculum and pedagogical decisions the youth made in creating the unit. In particular, I look at how the youth chose to focus on food and nutrition and what content they selected. I also focus on the pedagogical decisions youth made and how they decided to enact the teaching of content in those ways. Undergirding these ideas are two key points: (1) youths' previous YPAR research and experience informed the decision to teach food and nutrition; and (2) the goals of teaching the food and nutrition unit are deliberate actions against marginalizing science experiences for youth of color. I also provide an overview of the activities selected and designed by the youth and how they were organized into three lesson plans and describe the implementation of the lessons over three sessions with their younger peers. Finally, I offer analysis of the teaching unit

by considering the significance of the youth taking action to support STEM interest and opportunity for their peers.

I close this chapter in the discussion section by arguing that the action of teaching the food and nutrition unit allowed the youth to challenge many of the inequities they faced as students of color with STEM aspirations in an urban school. In particular I argue three points: (1) the youth positioned themselves as teachers and experts; (2) the youth created learning opportunities for their younger peers that reflected the kind of curricular and pedagogical opportunities they view as critical to their STEM careers but not accessible in their school, and (3) the youth created new and meaningful opportunities for themselves to learn new science.

Choosing to Teach Food and Nutrition

The decision to teach food and nutrition initially grew out of the youths' own concerns and frustrations with lunch options at school. The food and nutrition issues were not limited to school lunch but also extended into the home. The youth also believed that proper nourishment was necessary to have the energy to go to school and learn all day. The youth also connected health issues to poor eating habits and decisions including diabetes in the community.

For example, Lil c in particular, was critical of her school's lunches. During our research trip to the suburban school, she wrote in her observation notes "nice food court". We had arrived early and had time to walk around the building. The food court was also located centrally in the big foyer just beyond the main entrance. Since we still had time to pass after walking around the building, we spent a few minutes in the library. During our conversation, Lil c once again brought up the topic of food back at Murphy. During our visit, the youth also had a chance to interact with students at Lumpkin. One of the questions the youth asked was for the Lumpkin

students to ask them to talk about their school. Lil c had written that according to Lumpkin students, they have "better lunches than most schools."

Food was also a concern outside of school especially for Justice. She frequently mentioned how she did not eat all day until after school at the youth center. When I offered Justice a ride home from one of our meetings, I asked about why she didn't eat something in the mornings before school. She said that the options were limited and she didn't always have time to sit down and eat. School started early and plus she had to walk since she did not have a ride. She lived too close for school bus service but far enough that she needed to allow an extra one-half hour to get to school. She preferred to grab-and-go but didn't have fresh fruit or anything easily portable for her to eat on her walk to school. Her mother did the grocery shopping so she had to eat whatever was available at home.

Deelilah agreed that the food at school was not very good. Like Justice, there were days she did not eat at school. In terms of the way Deelilah prioritized issues at school, food issues were secondary to her other concerns. Therefore, she was not as outspoken in our sessions around food issues but did recognized that good nutrition and school success are linked.

Pedagogical Choices for the Food and Nutrition Unit

The youths' pedagogical decisions during the planning of the food and nutrition are grounded in their experiences and their YPAR investigations comparing their school to suburban schools. The youth identified the specific types of science experiences that were lacking in their own education. Those science learning experiences including the opportunity to conduct investigations, use technology, engage in cooperatively learning activities and apply their knowledge in a culminating experience. As a result, the planning of the food and nutrition unit was thus guided by a teaching pedagogy that emphasized experiences for their younger peers that

where not part of the regular science experience at school. The youth were adamant that their unit would not include any note-taking or busywork. While the youth may not have the benefit of a teacher education, they do have experiences as learners that suggest didactic teaching methods are not pedagogically effective.

For example, the youth had previously self-reported the infrequent opportunities at Murphy to do laboratory exercises and activities in their science classes. The youth had gathered data that indicated peers at other schools were more frequently engaged in laboratory settings and activities in science classes. At Lumpkin, they observed two classes both of which participated in laboratory activities. In one class, the students did a comparative investigation using samples of wood from different trees followed by gathering data from their plant growth experiment for which students determined the test conditions. In the descriptions of the lessons, I describe the pedagogical decisions used to include each of the major activities.

Roles of the Youth

The team of Justice, Lil c and Deelilah planned the food and nutrition unit to incorporate the types of experiences they identified as those they believed to be necessary for learning to be meaningful. As the planning took shape, Justice recommended that they divide the responsibilities so that they could be more productive rather than all trying to work on one part together (Field notes). They divided the planning responsibilities and each member took ownership for specific activities. Even though the activities were divided, the youth continued to work collaboratively inviting feedback and suggestions from the team members.

Justice took on the task of evaluating and identifying the online nutrition game that would be used to introduce the unit. All three youth at different times worked on selecting food items for the card sort but in the end Justice took responsibility for finishing the activity since less time

was needed to identify the online game. Lil c oversaw the planning of a laboratory investigation of food including selection of food samples for testing and designing the data sheet for the groups. Deelilah took the role of the generalist supporting the development of the different activities but was not able to oversee an activity due to her availability.

The work was completed across multiple days with different configurations of the three youth. Due to the voluntary nature of this project and their commitments to work and other obligations, there were occasions where one member was not present. Since the meeting space was at the local community center, the youth were in an environment with their peers. As such, the peers and adults in the building frequently stopped in to see what the youth were working on. Those occasions also presented opportunities to people on the periphery to step into the project for as long as they wanted and back out. Often, the people on the periphery despite their limited involvement made important contributions to the development of the teaching unit. In the detailed descriptions of the planning below, I have included instances where people outside the project influenced both the card sort activity and the culminating healthy menu activities.

Justice, Lil c and Deelilah were the primary leaders in the lesson design and teaching of the food and nutrition unit. Due to the fact two of the three lead planners and teachers were also employed as youth staff at the community center, they divided the teaching so that each person had the opportunity to take the lead for a lesson. The lesson was completed over three sessions with the younger peers. The youth emphasized activities that maximized the time youth were engaged in *doing* rather than listen. All three youth initiated the sessions with a brief overview of the lesson and instructions. Once the opening comments were provided, the younger peers worked in groups on the main activity of the lesson. The younger peers were voluntary members in grades 5-8 of an established informal science based program housed at the youth center. The

youth coordinated with leaders of the informal science program to make arrangements to teach their peers over three consecutive weeks. Since the lessons were taking place in an informal after school space, attendances varied but on average 15 younger peers were at each lesson.

The Food and Nutrition Unit

The next section of this chapter is organized around three lessons the youth implemented during the food and nutrition unit. The lessons were taught over three consecutive Tuesday afternoons at the youth center with the informal science group made up of middle grades peers. An overview of the lessons is found in Table 6.1. Below, I provided an overview of each lesson. Within each lesson, I provided description for each activity organized by: (1) description; (2) development; and (3) pedagogy. Then, a description of the implementation of the lesson follows. Organizing around each lesson provided a way to connect the components above to highlight what the youth did, how they made decisions, and how they were able to take action to provide their younger peers with a meaningful science learning experience around a topic of great importance to the youth. That is, the implementation section for each lesson identifies how teaching and unit design were informed by the findings of YPAR.

Table 6.1
Lessons of the Food and Nutrition Unit

	Lesson 1	Lesson 2	Lesson 3
Lead teacher	Justice	Deelilah	Lil c
Lesson goals	1. Introduce food and nutrition unit. 2. Engage younger peers with digital technology and group activity.	1. Conduct an investigation of food samples using the tools of science. 2. Propose a menu of healthy dishes	1. Apply learning from previous lessons to making a meal.
Lesson plan	1. Online Nutrition Game 2. Card Sort	1. Food Sample Testing Laboratory 2. Designing a Healthy Menu	1. Preparing a Healthy Meal

For each lesson, a different theme emerged during the implementation of the food and nutrition unit that exemplified what the youth desired in their own science experiences. The themes were connected to the nature of the lesson, the goals of the youth to teacher younger peers and the individual youth teacher leading the lesson. Justice, whose interactions with her peer learners reflected the type of teacher-student relationship the youth wanted in their science experiences, led the first lesson. She made an explicit point to visit each member in every group in her words, "even if they didn't need help" to make sure they were supported. During the second lesson, I focused on the intentional decision to use a laboratory exercise and the participation of the younger peers in using science practices. For the youth to intentionally place science equipment in the hands of their younger peers provided opportunities to imagine being a scientist and fought back against inequitable learning experiences. The third lesson was characterized by the opportunity to apply knowledge from the previous lessons to demonstrate the ability to evaluate healthy food choices. For example, the younger peers modified recipes during the preparation of the smoothies in order to make healthy choices based on what they learned about calories from sugar during the card sort activity.

Lesson 1: Engaging Food and Nutrition

The first lesson was designed by the youth to use technology and a group activity as tools for engaging the younger peers with starting to think about food and nutrition choices. The emergent theme centered on Justice's teaching practice and her interactions with the younger peers and the contrast to the way she described her science learning experiences. Justice engaged the younger peers to contemplate healthy food choices and asked each individual if they needed any help.

Activity 1: Online nutritional choice video game. The youth decided to use technology and the peer interest in video games to generate excitement for the food and nutrition unit.

Description. The game chosen by Justice, *Mission Nutrition*[1], served as an introduction to choosing healthy food options. The object of the game is to explore a virtual kitchen and identifying the best choices for snacks and drinks. For example, the game prompts the player to click on the refrigerator and identify the drink with the most sugar content. The game player can click on four different drink choices each of which produce a window with additional nutrition information about the item. There are quiz items built in that invite game players to test their knowledge about the nutritional value of some food and drink choices. Once the healthiest options are found, the game congratulates the player.

Development. Recognizing the strong appeal of video games among peers, the youth wanted to find an online nutrition game to begin the exploration. Justice conducted an online search for a game that would introduce the importance of healthy food choices to the younger peers. Other criteria included making sure the game could be completed in a reasonable amount of time so in order to do other activities during the lesson. Justice tried different games before settling on one she decided was best for the purpose of the activity and goals of the lesson.

Pedagogy. Access to technology as a tool for learning and engagement was a priority for the youth. The youth cited limited opportunities to use computer technology in their science classes. The limitations included lack of computers, outdated software and heavy reliance on teaching methods that did not implement technology. Yet, technologies including computers are a central part of science investigations and engineering. The youth also recognized the interest and desire of peers to access and work with computer technology in engaging ways that support

[1] http://kidshealth.org/kid/closet/games/game_nutrition.html

learning. Furthermore, the youth believed video games can support learning by getting students familiar and interested with the topic.

Activity 2: Using a card sort to make healthy choices. The youth wanted their younger peers to have opportunities to work cooperatively in groups and consider food choices from among popular options.

Description. The youth decided to identify several different food items with emphasis on what kids like to eat to do a card sort activity. They compiled a list of foods to include and planned to create two types of cards. One card had a picture of the food item. The matching card contained the nutrition label or facts. The goal was to have youth match a picture card with the nutrition label card in groups. The groups needed to evaluate the nutrition label by examining the amount of calories per serving as well as carbohydrate, protein and fat content. Once matches were made, the groups had to categorize the food as healthy, not healthy and not sure. The youth were very intentional in their planning to try to identify foods that would fall in the not sure category in order to stimulate group conversation about whether the food item was healthy or not healthy.

Development. During a work session, Justice was online researching different food items and their nutritional value. She identified different food and drink items for the cards. As she conducted searches, she engaged Lil c, was simultaneously developing the laboratory data sheet, in conversation looking for help identifying foods to including in the card sort. Specifically, Justice wanted help naming foods that people might consider being healthy but in reality are high in calories. Despite the request for help, the dialogue became Justice sharing what she was finding during her online search. To her own surprise, Justice was finding different foods that were not as nutritious as a person might be led to believe. The planning and designing of the card

sort had become a space for discovery for the youth. For example, the following dialogue shows how Justice and Lil c made discoveries as she developed the card sort activity:

Justice: I always thought fruit yogurts were healthy. But this says 170 calories. Wow. I was thinking about doing cereals. Something that everyone thinks is healthy like Kellogg's Fruit Loops.

Lil c: I thought that was healthy right?

Justice: Honey Smacks. You all know Honey Smacks?

Lil c: I hate that.

Justice: [Honey Smacks] are so good. I Googled "are Frosted Flakes healthy? Someone's like 'No. But they're great!' (laughter)

Justice: Dang! Everyone keeps saying Honey Smacks are so bad for you. Oh, Trix has no fiber.

During the work session, Justice decided to solicit input from other people for ideas of what to include on the cards. An important goal of the card sort activity was to invite the younger peers to have to contemplate whether the food items were healthy options. Justice wanted to find several examples that would push the younger peers to think rather than the more obvious choices that are either very high or low in calories and nutritional value. She stated, "I need to figure out what people think is healthy but is really not healthy" (Justice, Transcript, 2013). Justice and Lil c were busy working in an office space at the youth center with the door open. Passersby including other youth and adults would pass through some to see what they were working on. Justice started asked everyone that passed by in the vicinity for their ideas on foods that met her criteria.

A fellow teenager entered the room accompanied by an elementary school aged girl and sat down in open chairs. Justice explained what she was doing and asked them for help. The following exchange between Justice and the two visitors shows how ideas from others were considered in designing the card sort activity:

> Justice: We're doing a thing for GET City, We're doing a match. They're gonna match the nutrient facts up with the picture and see which one they think, you know what I'm saying, is what. Gatorade has 150 calories. I'm pretty sure a lot of people don't know that.
>
> Girl: Diet Pepsi?
>
> Justice: I put Diet Pepsi. I mean Diet Coke.
>
> Teen: Well any diet pop.
>
> Justice: What you think is healthy but is not?
>
> Girl: Slushees are not good for you.
>
> Justice: But I sure get them everyday, too!

Justice considered the input of the youth and playfully added that the slushees tempt her. In the next exchange, Justice is challenged by her teenaged peer and quickly reconsiders her initial statement. In the end, Justice includes salad options from a fast food restaurant in the final set of cards for the activity.

> Justice: You know the chicken sandwich at Wendy's that people think is healthy just cause it has chicken and lettuce.
>
> Teen: If you think any fast food restaurant isn't that healthy but…
>
> Justice: They say they have salads. Ooh, salads are always healthy.
>
> Teen: Uh-uh, they have more calories.

Justice: Especially at McDonald's, too. They have a lot of calories. They have almost 300 calories, 400 calories.

Justice gathered more input including many suggestions that she included in the final set of cards for the sorting activity.

Volunteer tutor: How about those chips? The Lay's Baked Chips. Are those?

Teen: Them fiber bars, too.

Volunteer tutor: Fiber bars aren't good?

Girl: Pop tarts aren't good for you.

Justice: Pop tarts aren't good for you. Good job!

Adult staff member 1: They're not good for you. All that sugar!

Adult staff member 2: You got subs?

Teen: Told you Subway.

Adult staff member: Subs in general. It doesn't have to be Subway.

As much as Justice set out with the intent of getting input, she created a space for different members of the youth center community to engage in the act of considering what are healthy food options. We see that the volunteer tutor asks whether a baked chip is truly better than fried chips. And from the teen's comment, the tutor was pushed to reconsider her ideas of whether cereal bars are good choices. The young girls actively contributed ideas that Justice praised. With regards to the sub sandwiches, the teen specifically references Subway whose advertising campaign often boasts healthy options including the dramatic weight loss of Jared, who's diet included sub sandwiches and has since become a pop culture figure. But the adult staff member reminds the room that any sandwich can be unhealthy.

Pedagogy. The cooperative learning activity was inspired in part by the comparative investigation at Lumpkin. The youth modeled their cooperative activity from their observations of the students in biology at Lumpkin using cards to construct a food web as a group. The teacher provided cards with pictures and information of different organisms from different trophic levels to each group of students. The groups were tasked with working together to build a food web directly on the blacktop laboratory tables using chalk to draw arrows to show the energy relationships between organisms. The youth observed and interacted with the Lumpkin students as they evaluated the organisms and considered the food relationships.

The youth wanted the younger peers to have opportunities to interact during learning. The groups they had observed at Lumpkin discussed reasons why they placed organisms in energy relationships with other species. Whereas at Murphy, the youth more frequently found themselves completing packets and busywork without much guidance from the teacher or opportunities to work cooperatively. The youth were especially interested in engaging their younger peers in conversation around food choices that are seemingly healthy recognizing that food labeling and advertising can be misleading.

Implementation of Lesson 1

Justice taught the first lesson that included the online nutrition game and card sort activities. She introduced the online video game and asked youth go online to the website she had pre-selected. The game required youth to open virtual cupboards and refrigerator and examine different food items. Then, the game prompted players to answer questions about the nutrition of the food items. Once everyone had a chance to play the game, Justice transitioned the large group into the card sort activity. After a brief set of instructions, the groups laid the cards out on the table and tried to match the picture of a food item with the corresponding nutrition

label. In the next step, the groups had to decide and organize the cards in clusters of healthy, not healthy, and not sure. While the groups worked with the cards, Justice circulated around the room and interacted with each of the groups.

Justice positively validated inquiries and encouraged the younger peer to use their abilities to explore whether the food item is healthy. For example, one might consider the conversations during the card sort between Justice and her younger peers to be the type of teacher-student interactions the youth desired in their own science learning experiences. Justice provided affirming responses that also left room for learners to think and continue to explore. In the following exchange, Justice reiterated the task at-hand for a group to which one of the peers is trying to figure out how to group one of the food items.

Peer 1: If it says zero calories and zero sugar grams [is it healthy]?

Justice: Yep. It's a good idea. You can try it that way

Justice did not avoid the question altogether and leave the task as busywork. Nor did she simply provide an answer that would have stripped the activity of any cognitive value. This is in direct contrast to Justice's experiences in science where help and guidance was not readily provided unless she came in after school. Rather, she was left to figure out assignments on her own without teacher support.

Justice was adept at inviting the younger peers to mentally engage with in the process of developing an understanding of nutrition concepts. One group was trying to figure out whether a chicken sandwich was healthy. Justice stopped at the table and asked questions to give the group factors to consider as they tried to decide whether the sandwich was healthy. She asked, "How many calories do you guys think this [has]? The chicken sandwich". She continued, "So you guys also have to think about the lettuce, tomatoes, mayonnaise" inviting the group to make sure

they took into consideration the different sources of calories as they evaluated whether the sandwich was a healthy option. The group members were also required work together by engaging in a conversation to develop a criterion for what they consider to be healthy food.

Justice continued to work with the group making sure the instructions were clear and explained, “Put the pictures right next to the ones you think are healthy. Do you want me to help you?” One of the group members responded, “No”. Two interesting points can be made here about this interaction. Justice provided direction and extended herself to be available for additional help if needed. From the accounts given by the participants, help is not always readily available during science class at school. But in this out of school moment where the participants are the teachers, Justice was available to assist students with the activity. Second, the response by the group member was noteworthy for the way the student was so engaged that she wanted to work through the task without extra assistance. Moments later, the girl can be heard asking her group, “This one has low sodium, hmmm?!” While the group initially looked at calories, now the group had to consider other factors as they expanded their criterion for the overall healthiness of the food items.

As the activity progressed, Justice made sure she was available to support the groups and insure that the groups were continuously assessing the healthiness of the food items depicted. For example, one group was considering whether the low fat or unfrosted version of the pre-packaged breakfast pastry, Pop Tarts, was truly better than the regular version.

Justice: So now let’s look at the Pop Tarts. One says low fat and one is just regular.

Peer 2: [Locating the nutrition facts for low fat Pop Tarts] Here is the low fat one.

Justice: Okay.

Peer 2: And this is unfrosted. [Locating another nutrition fact card]

Peer 3: So it's one more of them [nutrition facts card for the regular Pop Tarts]

Justice: Did you find the other one?

Adult volunteer: Oh my gosh, there's unfrosted Pop Tarts? I didn't even know they are real.

Peer 2: That sounds gross.

Justice: I mean you think they'd be healthier but..

Peer 3: They're not?

Justice: Well, let's see.

Justice interacted with the groups to stimulate and facilitate discussion as to whether any of the Pop Tart varieties was a better option. In the exchange, one of the peers is clearly wondering whether unfrosted pastry is necessarily better. And without answering the question, Justice left an opening for the group to ask and investigate the question asked by the group member. Justice avoided giving the group the answer but also left them positioned to move forward with a tangible goal. The group is thus able to continue with the task unlike Justice's school experiences of having to come in after school for help because she can't get that support in class. The group continued to examine the nutrition facts and focused on the fat content of the Pop Tarts. Before Justice moved to another group, she added, "Good job! Alright. You guys are doing good. Now we're just gonna move on to this one [another food item to evaluate]". Justice praised the work of the group affirming their efforts and gave direction for the next task. Again, this contrasts with Justice's experience where her teacher is pre-occupied with using negative reinforcement in dealing with student behavior.

When the groups get distracted or off task, Justice was playful rather than punitive and redirecting the focus back to the task. In one group, the attention shifted to a cell phone that was

taken by one of the members. Justice jokingly quipped, “you don’t have nobody to text, anyways”. She quickly diverted the attention of the group back to the card sort by adding, “Okay, so Gatorade. Let’s look at this. How much calories do you guys think Gatorade has in it?” A girl in the group answered, “About a 100 [calories]”. It needs to be pointed out that Justice, as a junior staff member at the youth center, has a rapport with many of the younger peers so she is able to playfully tease about texting. But the significance of the move was the way she refocused the group without letting the issue around the cell phone escalate into a major distraction or seek to punish the person with the phone. Her skillful and tactical move was predicated on an established relationship with the girls in the group. Whereas in school, the youth often feel that teachers do not respect students and therefore set up barriers to a relationship that allows Justice to both diffuse a situation and help the group continue working effectively.

Lesson 2: Exploring Food Samples through a Laboratory Investigation

The theme of the second lesson centered on the participation and engagement of the younger peers with science practices. Rather than solely focusing on how science practices are taken up by the youth, more needs to be said about the significance of simply having a space in which to participate in the doing of science. Stemming from the youth lamentation of infrequent laboratory opportunities, we see that explicitly choosing to include a lab activity affords the youth space to roleplay that of a scientist. In school classrooms that do not invite youth to roleplay as scientists, a STEM career trajectory is pushed farther out of reach if youth never imagine themselves as being able to do science.

Activity 3: Testing foods using the tools of science. The youth wanted their peers to have the opportunity to experience an authentic laboratory investigation during the food and nutrition unit.

Description. The laboratory exercise selected by the youth tested various foods for the presence of carbohydrates, proteins and lipids. While in biology classrooms, teachers often use the lab during the unit on the molecules of life, the youth adapted the lab for their unit. The laboratory exercise involved using chemical indicators to test for the substances described above. The testing involved samples of food items that were pipetted into a testing tray. Then, the indicator corresponding to the substance being tested for was added to each sample. The indicator would produce a visible color reaction for a positive test. In addition, solid food samples could be tested for the presence of lipids using a paper test. If a food sample placed on a clean square from a brown paper bag left an oily stain, the test was positive for lipids.

Development. The process for selecting a laboratory experience that would compliment the food and nutrition unit was challenging in that the youth often chose to draw from their own experiences. But in their experiences, the youth had not completed a lab experience related to food and nutrition. The youth conducted Internet searches for "food labs" but did not find one to their liking. As acknowledged in the methodology, I did take on the role of participant at times including in the planning of a lab activity. The youth asked me for help given my background as a secondary science teacher. I suggested the lab, which is used in biology classrooms to demonstrate the presence of the molecules of life (carbohydrates, proteins, lipids, and nucleic acids).

Lil c took the lead to develop a data sheet for the youth to fill out the test results. She also included a column for predictions to invite the younger peers to think about the investigation and food items being tested in advance. In the next step, the team of youth participants selected the food items to be tested. They relied on their own knowledge of what molecules might be contained in common food items. Between suggested items on the lab lesson found online and

their own ideas, the youth generated a list of food items to test. Prior to the implementation of the lab, the youth tried the investigation in order to know what results to expect.

Pedagogy. The youth were very clear in wanting to include laboratory investigations in their unit. For the youth, labs were a hallmark of learning science. They wanted to engage their younger peers in the act of doing science instead of hearing and reading about science as is the norm in many science lessons at school. A few youth did experience laboratory exercises in greater frequency but most indicated as described earlier in the science experiences chapter limited number of investigations in several classes. For example, Malcolm did not experience laboratory investigations in physics. On the other hand, Lil c reported that her chemistry made a concerted effort to have the class do labs once a week on Fridays despite having 46 students in the class. While those represent extremes, what is more typical is closer to what Deelilah reported suggesting that labs were infrequent but not completely absent. In biology, Deelilah investigated pond water organisms but that was only one of a few labs over the course of a semester. In an interview with a teacher at Lumpkin, the youth learned that the he tried to plan labs or activities 4-5 times per week (field notes).

Implementation of Lesson 2

Deelilah led the second lesson that included the food lab despite not having been able to join the group on the day they tried out the lab. Justice joined the session after finishing her work shift at the youth center. Deelilah explained that each group needed to test different food samples for carbohydrates, proteins and lipids. Each group received 10 different food samples and a group data sheet. The groups were instructed to complete their set of predictions for each of the food samples and whether they contained the different components they were going to test for. (Figure 6.2 & 6.3)

Figure 6.1. Photograph: Deelilah demonstrates how to pipette test solutions.

Figure 6.2. Photograph: Justice assists a group during the food test laboratory activity.

Each group member was able to choose food samples they wanted to test from the available choices. The younger peers took turns writing down the samples on the group data sheet and discussed whether they believed particular samples had carbohydrates, proteins or lipids. They made predictions for each of the types of food molecules for all of their samples. By making predictions, the younger peers activated knowledge they had of each food item and gave reasons. For example, the groups discussed flavor to see if they could determine whether carbohydrates (sugars) were present in the food sample. The youth predicted that sweet items like apple juice contained carbohydrates as shown on group data sheets.

The groups loaded each of their food samples into three wells on a testing tray for the different tests. A fourth test had to be completed with a hot water bath so the groups left some of

the sample in the sealable containers. Once the indicator was added to the sample container, it was placed in a modified hot water bath. Each group had a bowl of hot water as a makeshift hot water bath. The water had cooled in some groups and caused a false negative test for sugar. The result caused youth to consider why their prediction was not confirmed by the test. They correctly diagnosed the problem with the test itself, not the lack of sugar in apple juice based on prior tasting and consumption. The groups also test cheese for the presence of lipids (fat) by placing a sample on a piece of a brown paper bag and waited to observe whether a stain was created. As controls, groups also added a water drop and an oil drop to show evaporation of water does not leave a stain like lipids.

The chosen laboratory exercise of testing food items for the presence of carbohydrates, proteins and lipids may not exemplify what an authentic science investigation fully entails, but it is a powerful tool for helping youth of color gain entry into spaces from which their school experiences have routinely excluded them. In the space created, youth are able to ask questions, work with science equipment and participate in discovery while doing so in a way that is safe and supported. Based on the commentary during the laboratory activity, the younger peers were engaged in ways that promoted a positive experience in doing science.

During the lab activity, one of the younger peers blurted out, “I’m a scientist!” What may seem like an innocuous comment can be quite significant when juxtaposed against the explicit desire of the youth to include a laboratory activity during lesson planning. The comment confirmed the belief by youth that an essential part of science learning is to do labs. Labs are more exciting that lectures but also a space for learners to try out identities and imagine themselves as scientists.

A college student volunteer sat in with one of the groups during the lab to assist as needed. The presence of the volunteer further helped validate the experience the group members were gaining during the lab. In one exchange, the volunteer is heard telling the group, “We did this lab, like seriously, in my college lab class”. One of the group members asked, “Really?” The volunteer answered, “Like this exact lab. Well, its very similar”. While the remark from the youth reveals a degree of surprise, the are not simply doing science but rather doing college level science. Again, the point is not that the lab was in fact college level, but reaffirming for youth to have a powerful learning experience that builds capacity to have and support STEM aspirations.

The excitement to do the lab activity by the groups was evident. At one point, an adult asks a group if they have finished making their predictions. One of the younger peers called out in response, “Yeah, can we hurry up and do the test?!” The peers remind us that they enter learning opportunities with curiosity and anticipation. But too often, school science does not match the expectations of the students. After making predictions, the groups tested their food items. The reactions between indicators and food samples produced colorful reactions. In one group, a member responded, “Oh, that is so neat!” at seeing the color changes. During the starch test, one of the group members had just added the iodine-based indicator into a sample of corn producing a positive test. She exclaimed, “Oh, look at the corn! It turned blue. The corn turned blue. Ahhh!” The moment of surprise is not trivial. Rather, the group fascinated but also curious to understand why the reaction occurred and why the reddish brown indicator caused the sample to turn blue. A boy in the group asked, “Why did it turn blue?” By making the choice to include a lab experience, the youth created an opportunity for their peers to “be scientists” but also spark their interest in science investigations.

Lesson 3: Making Healthy Choices to Design a Meal

The theme and purpose of the final lesson in the unit was to engage the younger peers in applying their learning of food and nutrition and to celebrate. The younger peers used their learning and prior knowledge to make decisions regarding their menu item to prepare. An important second outcome emerged in the dissemination of knowledge about food and nutrition. One group extended the message of eating healthy food to a larger audience at the youth center by sharing the healthy fruit salad they had prepared.

Activity 4: Preparing a healthy menu. The youth wanted the younger peers to be able to demonstrate their learning by selecting healthy food options to construct a menu that included different courses of a meal.

Description. The healthy menu activity called for each group to choose courses they wanted to serve that they deemed to be healthy. Within each group, they had to evaluate whether the courses were in fact healthy by considering the nutrition of each suggestion. The groups were to evaluate the food drawing from their experience gained in the card sort and the laboratory activity from the previous lessons. The groups had to evaluate how much sugar, protein and fat (calories) the foods contained. Each group submitted their menu for consideration by the youth instructors. Once the groups completed their menus, Justice, Lil c and Deelilah evaluated the suggested courses on the menus they had received. In addition to the nutritional value and consistency with the goals of the activity, the youth consider the feasibility of preparing the course based on the complexity in terms of ingredients, preparation and time to cook given that three groups would simultaneously share the kitchen. The three youth chose different courses that would be prepared by the younger peers in groups during the final lesson.

Development. The final activity was both a synthesis of learning but also a celebratory opportunity inspired by a friend of Lil c[2]. The friend sat in with the group during the planning and offered to help. The youth in the project were already working on the different parts of the unit but still felt we needed a strong culminating activity. Lil c's friend asked since the kids like to eat and they have been investigating food, shouldn't they get to eat some food? I asked him what the goal would be for the activity. I wrote in my field notes, "Eventually, the idea blossomed into have the GET City kids prepare a healthy menu and actually making it for themselves and some guests. Given that the club has a kitchen, this seems quite feasible if we work around snack time".

The youth participants agreed and decided to conclude the unit with a meal prepared by their younger peers. The youth wanted their younger peers to draw upon what they learned in the previous two lessons to develop a menu for a healthy meal. The friend drafted the language that would make up the instructions for the activity. Later, the group added boxes to the document so that each group could list suggested courses for the meal.

Pedagogy. The preparation of a healthy menu was consistent with the pedagogical goals of the youth to have the younger peers working cooperatively. The groups deliberating menu items and working together to prepare the courses for the meal supported cooperative learning. As Justice stated and was quoted in her science narrative earlier, science class needed to be "funner". The opportunity to prepare and eat food was consistent with making learning fun. During the time in the kitchen, one boy enthusiastically asked, "Are we gonna have a feast when

[2] The friend is a teenager and member of the youth center. The young man for health reasons was not able to regularly visit the youth center and join the project. At the time, he was slated to undergo a major medical procedure and was aware of the risks involved. Lil c frequently reiterated that he mentioned how scared he was and that he wanted to do as much as possible before the procedure. Therefore, he did sit in during a few sessions during the span of the project and worked to contribute as much as possible during those sessions.

it's all done?" (Transcript). And less explicit in the conversation among youth but nonetheless important as a pedagogical decision, the younger peers applied their knowledge of food and nutrition to develop the menus.

Implementation of Lesson 3

The week before, after completing the lab the groups had developed healthy menus. The three teachers had reviewed the menus created by each group and selected items that could be prepared during the final lesson. The youth center had a kitchen available so that groups would be able to prepare their suggested dishes. The youth identified dishes that were healthy, appealing to the youth, and easily prepared in the time we had allotted for each session. From the proposed menus, the youth settled on macaroni and cheese, fruit salad, and smoothies. Three items were selected based so that each group could to prepare one item. The youth selected macaroni and cheese, which may not necessarily be healthy depending on preparation, because they felt it was a favorite dish among their peers. They decided to have the group assigned to making macaroni and cheese prepare two versions for a taste test. Using the same base recipe, the youth wanted to prepare one with reduced fat and calories ingredients and the other with regular ingredients. For the fruit salad, the youth selected to include fruit that they felt their peer would enjoy. They included pineapple, grapes, strawberries and melon. The smoothie group used a no sugar-added recipe that included mixed berries, bananas, orange juice and low fat vanilla yogurt.

Lil c led the final lesson on the unit the younger peers prepared their healthy meals. She introduced the final menus and assigned groups a course to prepare. After explained the courses to be prepared, the groups were instructed to move to their stations in the kitchen and begin preparing the courses. Lil c moved among the groups to assist and answer questions.

As the groups were preparing their menu item, the smoothie group produced the first batch and shared samples with their peers. Almost instantly, the youth provided various feedback as they tasted the smoothies. In the video of the kitchen session, the following dialogue was heard:

Peer 1: It needs some sugar.

Peer 2: It's good. It's just thick. Can we blend it up a little bit more?

Peer 3: It tastes a lot like bananas.

A moment later, Peer 1 walks over and looks directly in the camera adding commentary about the smoothie. He held the cup up to the camera and stated, "This is a sample of the smoothie. It tastes like bubble gum. Bubble gum". He proceeded to take a sip on camera before declaring "Very tasty!" Then Peer 2 walks up to the camera and added, "It needs to be blended up more. It's too thick." (Figure 6.4)

Figure 6.3. Photograph: The smoothie group works to adjust their recipe based on feedback from their peers without adding extra sugar for sweetness.

The series of instant feedback pushed the smoothie group to consider ways to modify their recipe for the different taste preferences. The smoothie group took it upon themselves to experiment with the base recipe to create a drink that had the desired flavor and also adjusted the recipe to the preferences of individuals. In particular, they wanted to know if they could modify the amount of ingredients to make for a sweeter smoothie without adding refined sugar. The group made different batches also adjusting for some people who expressed that they did not like bananas. One of the younger peers found sugar in the cupboards of the kitchen but the group making smoothies refused to use any worried about reducing the nutritional value of their fruit concoctions. The argument can be made that the youth in the smoothie group and learned the

importance of making good decisions around food choices. That is, the youth teachers had achieved one goal of the food and nutrition as observed in this scenario.

During the process of preparing the meal, the macaroni and cheese group had to consider the ingredients to make a healthier version to compare with the regular version. The group was provided with ingredients that included low fat and calorie options as well as a choice of pasta. They were asked to decide whether to use whole grain macaroni or hidden vegetable macaroni in the healthier version. The hidden vegetable macaroni was a regular pasta enriched with corn, squash, and carrots. The group deliberated about which pasta to choose. Lil c implored the group to make the whole grain version as she declared, “Let’s do the wheat! Let’s do the wheat!” The group overrode Lil c by choosing the hidden veggie version because it looked more like regular pasta. The whole grain version was much darker in color as they worried the flavor and texture would not be as appealing. They also made decisions on how much butter to use cutting back by half of what the recipe required. They used reduced fat cheese and reduced fat evaporated milk to make the cheese sauce. (Figure 6.5).

Figure 6.4. Photograph: Lil c helps serve the regular and healthy versions of macaroni and cheese prepared by the younger peers.

The macaroni and cheese group prepared the regular recipe and a reduced fat and calorie version. Once the food was ready, all of the groups got to try both versions of the macaroni and most reported they preferred the healthier version. Peer 1, the same boy who commented on the smoothie directly into the video camera decided that he liked the reduced calorie macaroni, “The healthy one is the best. It tastes more real. The cheese is more real. The noodles. The texture of them”. The youth decision to include macaroni and cheese on the menu was affirmed by Peer 1 who added, “My mom used to eat this all the time when she was pregnant with me and I was born eating macaroni”. Another peer concurred that the healthy macaroni was better as she stated, "The healthy one, it tastes like. I don’t know how you explain it. Like the cheese, tastes better, like a lot better.” Lil c also shared her preference and said, “The healthy one tastes better. It

tastes like the real unhealthy one we usually eat. It tastes the same way [as the regular version]". So, some of the reasons varied from taste of the cheese to the texture due to the thickness of the sauce. For one of the girls, she liked the regular version "because it wasn't that chunky. That thick" and added that "they taste the same". Of course, not everyone including Peer 1's younger sister cared for either version of macaroni. She stated, "I don't like nobody else's macaroni but my mother's".

The fruit salad group washed, cut, and mixed their ingredients and ended up with an extra-large batch. The group also improvised by getting permission from the youth center staff to add the extra bananas that were left over from lunch service earlier in the day. Given the excessive batch size, the group decided they wanted to share a healthy snack with other members and staff at the youth center. One group member carried the large bowl and serving spoon and was accompanied by two others who followed with serving dishes and utensils. It's worth noting that the fruit salad group created a positive unintended alternative by providing access to healthy and fresh fruit salad within the youth center. Typically, snacks provided by the youth center included heavily processed and packaged cookies or crackers. The youth center also runs a canteen that sells hot dogs, nachos, candy, flavored ice pops and other options.

Learning Science through Experiences

The description above of the macaroni and cheese taste test is important to describe because of the value of having experiences underscores the achievement of the youth teachers to convey the importance of making healthy food choices. The youth teachers wanted their peers to know that they could still enjoy the foods they like and prepare them with less calories. While some still preferred the regular version, several liked the reduced fat and calories version. One of the peers echoed a sentiment shared by others regarding the choice of activities by the youth

teachers when she said, “It was fun because we got to make food”. While the comment seemingly reduced the activity to having fun through cooking, embedded is the importance of learning through experience. The experiences included learning to evaluate nutrition labels during the card sort activity so that knowledge could be applied when making decisions for making the macaroni and cheese. Peer 1 praised the youth teachers stating, “They were smart with what they did and they taught us that healthy food could be good”.

The laboratory experience of the second lesson was memorable for the younger peers especially for the visually captivating reactions. Regarding the lab, one peer commented, “That was fun. It was cool because one of the things, the milk when we squirted, when we put the… It was one of those tests we did, it started swirling around. It was sweet.” She was referring to the visible pattern produced by the reaction of the indicator for lipids and milk. Another peer added about the same reaction, “It was cool because one of our things, we put something in it and it made a flower.” To her, the reaction resembled a flower. The younger peers may not have explicitly talked about the learning taking place during the lab when sharing highlights of their experiences, having to make predictions and test the food samples engaged them in considering which foods have carbohydrates, proteins and lipids. In the following exchange between two girls in the fifth grade, they recorded their predictions on the provided data sheet while pondering which molecules were in milk:

Girl 1: Milk. M-I-L-K [spelling it out]. Do you think that it has carbs in it? Sugar?

Girl 2: You can put some in there [a well in the test tray].

Girl 1: So is that a yes or a no?

Girl 2: Yes.

Girl 1: Do you think it has fats and oil?

Girl 2: Um……

Girl 1: No?

Girl 2: No.

Girl 1: Say it louder please.

Girl 2: NO!

Girl 1: Thank you! Do you think it has proteins? Meat and beans?

Girl 2: No!

Girl 1: No? Okay. Next is rice.

The decision to ask for predictions opened a space for each group to engage in conversation. The two girls had to actively think about which molecules are contained in the food samples. At this point, the girls did not necessarily provide supporting reasons as that was the purpose of testing the samples in the lab activity. Furthermore, the food molecules corresponded with nutrition labels previously examined in the card sort activity. The younger peers moved from considering the nutrition of favorite foods in the card sort to thinking more deeply about the specific components that make up and add calories to foods.

Teaching Feedback from Younger Peers

The youth wanted critical feedback on their teaching and to find out if and what the younger peers gained from the lessons. They interviewed three of their younger peers who participated in the food and nutrition unit two weeks after teaching was completed. The youth developed interview questions for their younger peers and generated feedback that addressed: (1) youth teaching critiques and praise; (2) suggestions for improvement; (3) comparisons to school science experiences; and (4) learning outcomes from the unit.

The younger peers enjoyed having the youth teach a food and nutrition unit. Peer 1, the same boy introduced earlier, appreciated the youth instructors' ability to relate to him due to proximity in age. He stated, "Let someone teach us that's a little more closer to our age and we'd probably understand them better" (Peer 1, Interview, 2013). Girl 1, also introduced above, added that the youth should "stop by and help us with the GET City program" (Girl 1, Interview, 2013). GET City is the informal science program in which the younger peers are participants. Girl 1 was satisfied with the food and nutrition lessons and added that the youth should change "nothing" with their teaching. The third peer interviewed, identified here as Girl 3, is an eighth grade student. Justice asked whether the youth teachers paid enough attention drawing from her commitments to supporting each learner unlike her own school experiences. Girl 3 singled out and praised Justice as she declared, "You did. You were good!" Justice's personal teaching goal was affirmed in this declaration.

The critiques were constructive toward how the youth can improved their teaching. Girl 3 suggested "more organization and interacting". Given that the youth were teaching for the first time, understandably during implementation the lessons may not have appeared as well structured as an experienced classroom teacher. She also pushed for "having more active activities. Like getting up and moving around". One way to make sense of the statement is to consider how much time students spend seated doing deskwork at school and her desire to be up and mobile as young, energetic beings.

The youth questions elicited responses of the younger peers that indicated that school science experiences are similar to their own. That is, the opportunities to actively engage in learning science are limited. The younger peers were asked to compare the food and nutrition unit to learning science in school. Peer 1 stated, "We don't do anything like [the food and

nutrition unit]. We do the same old textbook stuff all the time and probably the same experiments like regular volcano, rocks and mineral stuff all the time." He added, "[the youth] don't teach us as much as our teacher does [in a year] but in one day of science they probably taught us more than our teachers. Instead of just reading two pages and then doing questions over." Peer 1's commented suggested a lack of learning experiences like the one provided by the youth. Learning relied heavily on busywork and lessons repeated across grade levels such as studying volcanoes. Girl 3 had similar science experiences at school as Peer 1. She stated, "[School lessons] aren't as interactive. They are boring. (Girl 3, Interview, 2013). The following exchange captured the shared sentiments of Girl 3 as Justice led the interview:

> Justice: So what did we do that's different than what your school did?
>
> Girl 3: It was fun.
>
> Justice: Okay, thank you. Did you learn as much with us as you [did] with your science teacher?
>
> Girl 3: I learned more with you guys. My science teacher don't teach us. She just gives us packets. And the we gotta do the packet and turn it in.
>
> Justice: So much like what I do.

Girl 3 enjoyed learning from the youth and expressed the same narrative told by Justice and the other youth. Repeatedly, the youth have lamented over the teaching practices that fail to invite students to find joy in learning. Too often, youth of color are subjected to achievement gap narratives that characterize youth as disinterested in science. But, when Justice asked Girl 3 what she would want the youth to teach if they were to do another lesson, she answered, "Whatever you want to teach me". The comment from Girl 3 showed her desire and openness to learning regardless of topic but as she indicated earlier in ways that are fun and active.

The youth asked the younger peers what they learned across the lessons on food and nutrition. Girl 1 said she learned to "start eating healthy stuff". Girl 3 was present for the first and third lessons spoke about what she learned for each lesson. She said, "First one, I learned that you should pay attention to the nutrient facts. And then the third one, I learned that good food can be healthy. That it was easy to make" (Girl 3, Interview, 2013). As for what Girl 1 wanted to learn, she said, "More healthy stuff". Two weeks later, in addition to the learning experiences, the overarching takeaway messages remained with the younger peers that potentially have important ramifications for their long-term health.

Youth Reflection on Teaching

> "I enjoyed it. I love teaching them because I don't know. I just felt like you felt like a teacher. I felt like a teacher. Like you know you have to plan it before and it just shows that teachers it's not that easy. But teachers have to do their best. And I like that they learned something that I can say I actually taught them something and they can came up to me and like "I remember when you taught" and it's just a good experience to me". (Justice, Interview, 2013)

The quote from Justice captured the mutually beneficial outcome of the youth decision to teach their younger peers. She reflected the positive experience of being a teacher and the pride in knowing the youth learned due to her action. Justice also gained a sense of understanding for the challenges of being a good teacher acknowledging that it's not easy. But in the end, Justice stated, "I think we did good because they said that they had fun with our experiences and doing more projects instead of just sitting there listening to us talk. That was fun. Really fun." She had a wonderful experience and believed that her younger peers did as well. She attributed success to having provided activities that engaged the learners.

For Deelilah, the personal value of teaching was strongly expressed in her reflection after the unit. Deelilah gained knowledge through participating in teaching doing the lab with the younger peers. Not only did she teach, she also went around to the groups during the lab and helped with the testing of the food samples by adding the test solution for some groups. In her words, "I like the chemical part, testing the foods and stuff. It was like stuff you didn't even know had sugar and it had a lot of sugar and all that stuff." The comment revealed a different view on the teacher-student relationship in which learning is cooperative. United with the peers, Deelilah was learning about the nutrition of different foods and pushed her own thinking just as they wished to do for the peers. She contemplated her eating decisions and the importance of teaching the peers about food stating, "Because I don't eat healthy. Maybe they should eat healthy, you know. Drop the habit." She wanted to transform her eating habits and those of the peers recognizing the importance of a healthy diet.

For Lil c, the opportunity to teach the younger peers "was a good experience". She noted "that they actually paid attention and listened to us. They were interested in what we were teaching." The comment was not meant to suggest the younger peers were not attentive. Rather, Lil c meant that the attentiveness of the younger peers is unlike what she typically sees when other students at school disengage from the lessons being taught. Lil c elaborated on the engagement of the younger peers and stated, "We did good. [We taught] The same way [as our teachers] pretty much except for the hands on. We did more hands on stuff". Her assessment after the unit reflected consistency with the pedagogical decision made at the beginning of planning. Furthermore, the youth found that including hands on activities engaged the attention and critical thinking of the younger peers. Lil c deemed the teaching unit a success citing that the

younger peers learned “that healthy food is not that bad”. According to Lil c, “[the younger peers] said it was fun and they wanted to [have us teach] again”.

The youth concluded that they did many things as well, if not better than their teachers at school. Deelilah argued the youth did a better job of teaching “because we helped them understand and our teachers don’t help us and like they can ask us the same question like three times like they did. Me I could’ve gotten frustrated like teachers do but I wanted to help them.” Justice attributed their successful teaching unit declaring, “We’re more patient. And we put it in better ways that they can understand it. Like since we’re closer to their age, we know different ways that we could teach them. Or like relate to them so that they can understand the work and material.”

As an observer, the most powerful moments were when the youth during each of the lessons circulated the room and worked one-to-one and in small groups with the learners. In these spaces, the youth teachers could engage their peers and support their learning. Justice stated, “I went around and interacted with them and see like did they understand? Make sure they know exactly, not just make sure they’re doing it and know exactly what they were doing. Because you know sometimes I do that like in class. If I don’t know, I just act like I know what I’m doing and I make sure they know exactly what they were doing. So that they learn something.” She added that her goal was to make sure she checked in with every individual during the activity even if they didn’t need help. Justice hinted at how she approached her schooling experiences by sometimes resorting to pretending to know what was supposed to be learned. But, as a teacher, she is committed to actual gains of her peers. Justice’s actions at school in her own learning were the opposite of what she desired for the peer learners.

The youth also interrogated their own teaching, something they did not frequently observe among the teachers at their school. In fact, only Justice's physics teacher invited students to provide feedback on his teaching and sought to improve his practice. Justice talked about the physics teacher who asked students for feedback compared to other teachers:

> "Probably one. I had one this year. He asked us how he can make it funner. It was physics actually. But he's a new teacher, that's why. This is his first year. Yep. He's a good teacher. Not every physics teacher. Everybody failed. Like my brother been doing it for two years and he failed. But he did Wiggins [another physics teacher]."

Deelilah also had the teacher Justice described as the new teacher for a different class. The two girls indicated that this teacher was open to feedback and tried to find ways to encourage students unlike other teachers. According to the two girls, he promised to stand on his head "if we pass the quiz or get done in a certain amount of time." Doing a head stand to motivate students is not a prescribed teaching practice but the girls recognized this teacher's willingness to receive critique and attempts to demonstrate his desire for students to succeed. In considered what teachers can do to be more effective, Deelilah suggested, "They need to do better and have more patience. And don't make us do bookwork all day and actually help us understand what we're doing. Not moving so quick [through curriculum material]." Justice spoke to their strengths as youth teachers, "We're more patient. And we put it in better ways that they can understand it. Like since we're closer to their age, we know different ways that we could teach them. Or like relate to them so that they can understand the work and material."

In the comments of the youth, we are reminded not only of the strengths in their teaching but the implied commentary on the ways science is taught in school. The act of teaching by the youth was one way to transform the learning experiences and STEM trajectories of their peers.

Discussion: Youth Advocating for their Learning

The youth led science unit for younger peers was a form of direct action against the inequities exposed in the research for the purpose of positive transformation. The youth wanted to transform their experiences with science and their STEM trajectories but also for the middle school peers that would soon be in their situation. The food and nutrition unit allowed the youth to address the inequities in opportunity at Murphy both to take courses and to experience laboratory investigations while simultaneously seeking to inspire peers to pursue STEM interests. Consistent with YPAR, these actions aimed to address justice issues in science learning opportunities that otherwise marginalize youth of color.

As stated earlier, in this section I make three points regarding how youth engaged in direction action against the inequities they experienced in science education, and advocated for their own science learning: (1) the youth positioned themselves as teachers and experts; (2) the youth created learning opportunities for their younger peers that reflected the kind of curricular and pedagogical opportunities they view as critical to their STEM careers but not accessible in their school, and (3) the youth created new and meaningful opportunities for themselves to learn new science.

Youth Positioned Themselves as Teachers and Experts

By making the decision to teach their younger peers, the youth put themselves in the role of teacher and expert. One way to understand the youth decision to teach is to connect back to their curriculum guide comparison. The youth had found during their investigation that Smithers had a course for 11th and 12th grade students called Science Intern. The course description indicated the internship for credit would place students in the classroom of elementary school level teachers to assist in the planning and implementation of science activities.

> “Students enrolled in this course will work in the elementary schools directly with teachers and students. Students will prepare materials for the teaching of science at the elementary level and present materials. This course will give students who enjoy science an opportunity to share their enthusiasm with elementary students and it will give them the opportunity to do many demonstrations. Creativity in the development of interesting and understandable "hands on" experiences at the elementary level will be encouraged. (Smithers, p. 48)

Murphy did not offer science internship opportunities. Therefore, teaching a unit on food and nutrition to younger peers positioned the youth participants as equally capable to their counterparts at Smithers. In fact, the youth went a step further to directly plan and teach rather than only support a classroom teacher. The action of the youth to identify a critical topic around which to plan, design and implement a three lesson mini teaching unit extends beyond setting up materials and doing demonstrations under the supervision of the classroom teacher based on the course description from Smithers above. The youth participants confronted the inequity between schools and took direct action to create opportunities that were otherwise unavailable to students at Murphy.

As teachers for the food and nutrition unit, the youth were also experts in the experiences of their peers when it comes to the challenges of eating healthy. Like their younger peers, the youth faced similar choices in food at school and at outside of school. In the community, fast food options were abundant and popular with the youth and their peers. As junior staff at the youth center, the youth often worked in the canteen selling hotdogs, nachos with processed cheese, and sugary snacks to their peers. The youth used their expertise to inform their planning of the food and nutrition unit. For example, the selected foods to include in the card sort activity

came from youth knowledge of what was popular among their peers. Justice also solicited suggestions of food items to include from members of the youth center. The insider knowledge, or expertise, aided the youth in choosing a topic of importance to the community.

Creating Learning Opportunities for their Younger Peers

The youth articulated two main goals for their science unit on food and nutrition. First, the youth wanted to model what science teaching can and should more closely resemble in the classroom in light of their reported experiences. They wanted to design science experiences for their younger peers that included what they believed were the best ways to learn science. The instructional methods chosen were those used too infrequently in school settings according to the youth. Second, the youth wanted to teach a topic that was closely related to the needs of youth including themselves, peers and community. Food and nutrition was a particularly important issue for the youth because proper nourishment provided the energy to learn in school and impacted the health of students.

One way to understand the decision to teach is to understand how the unit worked to counteract inequitable learning opportunities. Choosing to teach younger peers allowed youth to develop opportunities that were otherwise missing from the science experiences at school. The youth created spaces to do the things they hadn't done and feared the younger peers were not getting either. If at Murphy the opportunities to do labs were limited as they were in middle school, the youth feared that the experiences for the younger peers were similarly lacking.

By using science equipment and chemicals, the youth wanted to provide an experience that allowed their peers to "be a scientist". Recall from the science narratives that for these youth, doing and experiencing labs is a central feature in science classrooms and to do a lab is to do science. Handling chemicals and using testing trays and pipettes symbolized the active

participation in science practices seldom provided in their classrooms. On the visit to Lumpkin, the youth observed students gathering data from the plants they were growing in the laboratory under variable conditions selected by the students as they measured water with graduated cylinders to give the plants and stored their specimens in trays under growing lamps. Thus, the youth created a space for youth to physically participate and see themselves as scientists by selecting an investigation that required the use of science equipment and chemicals.

In trying to provide lab experiences, the youth found obstacles as well. Whether in school or out of school, lab activities often require resources and materials. If the supplies are not readily accessible, opportunities for youth who are in underresourced schools and communities is further limited. For example, the youth were identifying food samples they wanted to have available for testing during the lab lesson. Justice asked how we were going to get all of the food samples and more specifically how would we pay for the food items. She suggested that she could ask her mother to get some of the items at the grocery store with her food stamps (Session X, 2013). I offered to help get the food items but Justice said that I should not have to pay for everything. So I suggested that I would check my refrigerator and kitchen cabinets for things I already had available. I was able to activate my university networks to obtain laboratory equipment including testing trays and pipettes. For Justice to offer to ask her mother to use food stamps for the family is a reminder that schools play an important role in providing learning experiences that youth might not otherwise be able to experience. And when schools especially in communities of color do not provide engaging learning opportunities, the students are further marginalized from being able to pursue STEM aspirations.

Creating New and Meaningful Opportunities for Themselves

Planning the lessons for the food and nutrition unit required youth to investigate content and test each of the activities prior to teaching thus creating new and meaningful opportunities for them to learn new science. Each step of the planning and implementation contributed to their own science learning. Although the intended audience was the younger peers, the youth researched the content they wanted to teach and evaluated multiple aspects in the process of planning. For example, Justice selected the online video game after reviewing multiple options and found the one that best fit the goals of the unit and purpose of using technology.

Designing the card sort activity allowed the youth to also use technology to conduct searches on the Internet for food items and the corresponding nutrition labels or facts. Justice reminded one group during the lesson to consider all of the condiments on a sandwich having discovered for earlier during the planning how many calories the added ingredients contribute. We see evidence of Justice and the other youth contemplating the nutrition of different food items in the description and dialogue from the planning of the card sort. Inviting people at the youth center that passed by the work space for suggestions for foods that seem healthy but may not be enabled the youth to investigate those items and determine whether to include them as cards.

The decision of the youth to have their younger peers conduct a laboratory experience created space for them to also do the activity. The youth selected the food lab activity because they had never done the lab in school. The youth conducted the experiment during planning in order to prepare to teach and to understand the goals of the investigation. Simultaneously, they discovered which foods contained carbohydrates, proteins and lipids. Thus, the lab supplemented the learning experience in school and addressed the lack of opportunity to do investigations.

For the last lesson, the youth were simultaneously participants and teachers. The youth evaluated the proposed menus from the younger peers. Once again, the youth furthered their learning by considering the nutritional value of the menu items and assessing whether the younger peers met the learning goals of the unit.

Connecting to CRT

The teaching unit was informed by several tenets of CRT but perhaps most centrally focused on transforming inequities impacting their community. The action toward social justice aimed at two sources of inequity. The food and nutrition unit tackled two pressing issues in the eyes of the youth facing their peers. First, they chose to take action against inequitable STEM opportunities by including teaching strategies they wanted in their experiences and that their peers needed to experience. Second, the youth addressed a major health-related concern facing people of color in which as others have documented how access to quality food is a social justice issue (Wekerle, 2004; Alkon & Norgaard, 2009) Guided by these concerns, youth enacted a plan of action as espouse by CRT to work toward social justice.

The youth teaching unit is a potentially significant and impactful experience for their peers as shown in the memorable science experiences youth recalled in their narratives. For example, as Malcolm and Caesar indicated, their informal science learning experiences had influential and lasting impact on how they came to view science and toward their STEM aspirations. The long-term impact of the teaching unit for the peers is not measured by this dissertation given time limitations, but the youth narratives give reason to be optimistic that their peers will later recall the food and nutrition unit as a source of inspiration toward their aspirations. The teens were also positioned at the youth center as leaders and role models and

thus positioned to have influence on their peers. It stands to reason that the positive relationship between the youth and their peers might also have a lasting impression.

The youth teaching unit is undoubtedly inspirational and powerful representation of their deep concern for improved science experiences and the health issues in the community enabled through the transformative capacity of YPAR. But, there is a deeply problematic reminder that the youth had to go outside the established education system charged with preparing students for their futures because their needs are not being met. Additionally, the difference in opportunity is magnified when students at nearby majority White schools are receiving more engaging science experiences and science course options. While the youth may have influenced the experiences of their peers, the institutional narratives are much larger and well entrenched that there is much more emancipatory work to be done to unseat the oppressive force of racism.

The action taken by the youth embodied the goal of CRT that seeks social justice. As described in Chapters 4 and 5, the youth shared their narratives and identified racism where it exists in their STEM opportunities to inform their action in this chapter. The teaching unit was informed by CRT and worked to transform the STEM experiences of their peers and deliver important lessons on the importance of making good food decisions for better health. Through YPAR and an understanding of systemic racism, the youth were able to take action and provided hope that the youth are better equipped to recruit peers and carry on the mission to fight for social justice. This project is a seed to larger, sustained efforts by youth of color toward eradicating racism along STEM trajectories but also in society.

Looking Forward

Overall, the full teaching unit on food and nutrition allowed the youth to take action against inequitable learning opportunities documented through YPAR. The youth took action and

advocated for their science learning and for their younger peers. Through teaching, the youth addressed differences in opportunities for students of color. For example, the Science Intern course offering at Smithers placed students in elementary classrooms to assist with laboratory exercises and science lessons. The youth in this project did not have the opportunity to be an intern with an elementary teacher through their school. The food and nutrition unit was a response by the youth to create opportunities for themselves that went beyond assisting. The positioned themselves as designers and teachers for the unit. The youth gained experiences learning about food and nutrition during planning and implementation of their lesson and engaged in learning pedagogies not readily seen in their school. They created opportunities for younger peers to share in the science experiences while addressing an issue of concern in the community.

CHAPTER 7

YPAR FOR TRANSFORMING POWER STRUCTURES

YPAR is a tool for confronting the power of the oppressor. Power is also the means by which racism is used to marginalize people of color. Thus, we need to consider how power is brokered in science. In order to understand the intersections of science education, critical race theory, and YPAR, I look at the role of power and privilege and how it comes to bear on STEM trajectories for youth of color. Power is central to each of the three components with direct implications for learners of color. I argue that science as an enterprise is possessed by a privileged few that creates power disparities between groups of people. Often, those oppressed by power and privileges of science are people of color as shown earlier in unequal educational outcomes data and decreasing presence in the STEM workforce. In society at-large, racism is maintained through the power of the dominant group to marginalize populations of color. The dominant group enjoys privileges in this case conferred by the color of their skin. Critical race theory works to name the oppression and eliminate racism. Thus, in the K-12 context, youth of color are more likely to be subjected to power discrepancies based on race and in science. As shown in the youth narratives within this investigation, youth of color received fewer options for science classes and less engaging science lessons. YPAR paired with an understanding of racism enabled youth to have voice and challenge the power structures of oppression in science education. Youth used research-based evidence to expose disparities along STEM pathways that disproportionately impact populations of color to take back power for learners of color through transformative action.

Science and Power

The enterprise of science, especially in the US, has been privileged at least since the former Soviet Union successfully launched Sputnik and has gained tremendous power as a subject area in education. The US responded by setting forth space exploration goals and spawned committees and curriculum studies that transformed the place of science within education. Schools encouraged more and more students to go into STEM fields. Thus, the US in seeking to retain status as a world power had also designated science and scientific knowledge as a source of power. To have superior scientific knowledge and technical abilities meant that the US could hold power over other nations. Essentially, science was a weapon in the Cold War between the US and Soviet Union that later heightened into the nuclear arms race and left outer space as a new battleground to be fought over. Whoever controlled outer space would gain an upper hand in the power struggle between nations through the use satellite technology to aid warfare and therefore STEM was at a premium.

Since the end of the Cold War, the US quest to remain in power as a world leader has shifted toward an economically driven imperative that continues to encourage more citizens to enter STEM fields. In the January 2011 State of the Union Address, US President Barack Obama stated:

> Half a century ago, when the Soviets beat us into space with the launch of a satellite called Sputnik, we had no idea how we would beat them to the moon. The science wasn't even there yet. NASA didn't exist. But after investing in better research and education, we didn't just surpass the Soviets; we unleashed a wave of innovation that created new industries and millions of new jobs. This is our generation's Sputnik moment. (Obama, 2011)

Obama compared the nation's current STEM workforce needs to the critical moment in history that changed the landscape of education arguably and irrevocably toward science and technology. Obama has argued that the US must stay competitive in the global marketplace stating, "Nations like China and India realized that with some changes of their own, they could compete in this new world. And so they started educating their children earlier and longer, with greater emphasis on math and science" (Obama, 2011). In response, Obama called for increasing the number of educators and students going into STEM fields.

The narratives of global supremacy have given unprecedented power and elevated status to science. Organizations such as the National Science Board, consisting of Presidentially-appointed, Senate-confirmed members, provide recommendations to the US President on STEM education policy (Beering, 2009). The NSB seemingly furthers the economic imperative messages and does not address disparities impacting learners of color.

In the classroom, narratives that we need the best and brightest students to go into STEM fields is problematic when coupled with deficit narratives that permeate schools serving large populations of color. The message suggests science is not for all students but especially not for students of color in schools shown to be on the wrong end of achievement data. Thus, when considering why Smithers offered more science courses than Murphy, I had the following exchange with Caesar:

Caesar: Smithers is higher quality school.

Me: That's what they want you to believe, right?

Caesar: No, it is though.

Me: Who goes to Smithers?

Caesar: Smart kids.

The dialogue showed how Caesar believed the majority White students at Smithers were privileged and empowered because they are "smarter" and have more science course offerings.

The youth also uncovered differences in power in student-teacher relationships in science classrooms. In general, science teachers are empowered with scientific knowledge that they are to impart on the students. Classrooms are already structured such that teachers are authority figures and students are submissive. From the narratives of the youth, they were further disempowered by their school science experiences filled with note taking and completion of worksheets. The youth were not given room to author any part of their science learning experiences. Whereas, in their observations at Lumpkin, teaching methods and activities allowed students more opportunities to work in groups to co-construct understanding rather than the teacher constantly in power to dictate what students learned. The disparities in science learning have long term effects especially in denying power through science to populations of color. Youth of color that are underserved by disempowering teaching methods are underprepared to compete with their privileged counterparts from other high schools for acceptance into college the continued pursuit of STEM aspirations.

Access to Science Pathways and Racism

People of color have been denied access to science, and science education by extension, through scientific racism and subsequent education policies throughout the history of education in the US. Science itself was used to promote the superiority of Caucasians and inferiority of people of color. As described in Chapter 2, craniometry was used to promote the alleged intellectual supremacy of Caucasians. For example, Ferguson (1916) delivered the idea of racial difference in his dissertation concluding Whites to be intellectually superior and going further to state, "Along with high emotionality and instability in character, defective morality is held to be

a negro characteristic" (p. 124). While science has debunked the notion of racial differences (Gould, 1996), the lasting impact remains deeply entrenched in systemic ways that continue to deny people of color opportunities to receive high quality opportunities to learn science.

Science education by extension, was historically exclusionary for most and a privilege for the elite before compulsory education. At the beginning of formal schooling in the U.S., schools were intended for the children of elite families of European descent. Most often, elite male children had access to education. For example, private preparatory schools emerged that served children of privileged families and taught them the classics including science so that they would be educated, cultured and refined. The treatment of education as a commodity for the privileged reinforced differences in access. Even when schooling became available to youth of color, schools were segregated maintaining unequal learning opportunities. Thusly, the dominant group was able to maintain their power and privilege by controlling the access to science education and more broadly education.

In light of limited access for student of color, Tate (2001) described science education as a civil rights issue that demanded "high-quality academic preparation, which includes the opportunity to learn science" (p. 1016). As this dissertation has shown, access to quality science learning for youth of color in high school was not available despite their STEM aspirations often due to institutional racism. Racism is systemic and not limited to the youth in this project. More recently, the racial microaggressions encountered by Black scientists and Black college science students was documented and underscored the racial marginalization that discourages science participation (Brown, Henderson, Gray, Sullivan, Donovan, Patterson & Wagstaff, 2012).

If we examine recent graduate studies statistics for Black recipients of doctorates in science and engineering in the US, we find consistent and disproportionate levels of attainment.

According to Jay (1977), between 1876-1930, only 13 doctorates in sciences were awarded to Black persons. Data from the National Science Foundation (1996) showed that Black persons earned 339 doctorates in science and engineering in 1986. In 1995, the number of Black persons receiving science and engineering doctorates increased to 557 (NSF, 1996). By 2008, the number of Black persons receiving a doctorate in science and engineering reached 824 according to a report from NSF (Fiegener, 2009). But, the increase in numbers does not tell the entire story. A closer look shows that the number of Black doctorates showed a steady increase in numbers but there was a proportionate *decline* for all minorities except Hispanics (Fiegener, 2009). Likewise, the *Journal of Blacks in Higher Education* (2006) reported an absence of Blacks receiving doctorates in several STEM fields. The JBHE identified several fields in which 2,100 doctorates were granted but not a single degree went to an African American. Furthermore, White doctoral students were more likely than Black doctoral students to receive appointments as teaching assistants (JBHE, 2006). The assertion by Brown et. al. (2012) showing the persistence of racism in science is consistent with the low number of doctorates earned by African Americans and underrepresentation in several STEM fields as well as teaching assistantships. While a connection between high school and college science experiences and attainment of doctorates by people of color is beyond the purview of this study, the issue of unequal access by racism warrants further PAR investigations that originate within communities that continue to be systematically denied access to science trajectories.

Racism and Power

Critical race theory argues that power is the mechanism through which the dominant group is able to assert its privilege over others. Racism works to keep oppressed populations in a subservient position. CRT also recognizes the intersectionality of race with class, socioeconomic

status, gender, and other social markers. Yet, as described in the literature review, racism is rarely considered in science education research. Failing to confront racism in science education thus reinforces the inequity in power between dominant groups and populations of color.

Racism is not always overt and thus is harder to detect without a critical lens through which to interrogate various means of oppression. The youth exposed several examples of how populations of color didn't receive equal support or opportunities to pursue STEM aspirations, but perhaps none more revealing of the subtle nature of racism than in the language of the curriculum guides they compared. In the curriculum guide for Murphy, a majority minority school, the introductory description of the career and technical section clearly promoted skilled labor careers for the students. The language used is not racist but rather misleading as they glamourize career and technical fields rather than promote college trajectories. Smithers description promotes college first and offers career and technical options as a means to earn money to pay for a college tuition. The cumulative effect of the two schools is to channel greater numbers of youth of color into skilled labor careers and White students into college trajectories. The earnings potential for White college graduates is greater than for people of color who completed career and technical program. The difference in the two approaches oppresses populations of color, and is therefore an act of systemic racism.

YPAR and Power

The power of YPAR is derived from the research tools and skills that youth use to investigate racism. Power is also found in the new spaces authored by the youth. Finally, there is power in understanding the structure through which racism is systemic. These three ideas are also the benefits of YPAR discussed in Chapter 5. YPAR matters because it is an important tool to transform social injustices and empowers youth to no longer accept compromised positions

imposed by those with power. In this investigation, youth of color authored spaces to have their voices heard by speaking back to the forces of oppression found along STEM pathways. Youth specifically fought back against the imbalance of power in science learning opportunities that are often racially oppressive.

YPAR is an important methodology that brings youth together around shared struggles and develops agency to transform social opportunities. The youth fought power with power gained through YPAR investigations. Research supported by data was harder to refute by those in power. Just as achievement gap research has imposed a deficit model on populations of color, the youth turned the tables to use research to fight barriers in their STEM trajectories. For example, the youth presented their work to an academic audience and transformed a conference space that does not usually allow youth voices. Representative of a shift in power achieved through YPAR, a national grant officer in attendance asked the youth for their recommendations on the types of STEM education research that the government should fund.

The food and nutrition teaching unit created a space for youth to take power over learning and empower their younger peers. The planning of lessons and testing of activities placed the power in the hands of the youth to acquire the scientific knowledge they did not get in school. The out of school space provided a safe environment to assume power and use teaching practices in the lessons for their younger peers that were withheld by teachers. And through teaching their younger peers, the youth countered the racism in teaching by showing they were not completely dependent on school science.

Implications

This investigation calls attention to the need to understand how racism forms barriers along STEM trajectories for youth of color. There are implications from the highest levels

through to the lowest levels. Starting at the top with the systemic level, there is a need to re-evaluate and work to eliminate the persistence of low expectations for students of color. The low expectations are linked to achievement gap narratives and deficit model perspectives assigned to students of color. The systemic narratives trickle down through the schools to the classroom. In one example at the school level, low expectations leads to counseling students out of taking a fourth year of science and disadvantages youth of color with college and STEM aspirations. At the classroom level, the YPAR investigations showed that students in a majority White suburban school are more frequently engaged in science investigations than the students of color at an urban school.

At the systemic level, the participants in this project are contributing their narratives as youth that can and youth that do. The youth actions ask whether the low expectations for youth of color are warranted. The relationship between the unequal educational outcomes and the most prevalent teaching practices in a majority minority school raise questions about the correlation. Those who use a deficit model might argue that the youth of color are not able to engage in authentic science investigations or handle cooperative group learning but the youth in this project are asking for more robust teaching practices in science. And when they do not receive the quality instruction, they take it upon themselves to make it available for their learning and for their younger peers.

The youth investigation also invites schools and school leaders to apply their research techniques to their own school publications to examine whether racism is a part of the hidden curriculum. As the youth discovered the blatantly different curriculum goals between their school and a nearby school, other schools can apply the same technique using a critical lens for

analysis to see whether the school is supporting youth toward college aspirations or short circuiting those dreams by promoting alternative pathways like career and technical education.

In regards to the classroom level, this YPAR investigation provides sound evidence that teaching practices can be racist. Overuse of disengaging teaching strategies diminishes student engagement and learning while failing to support STEM aspirations. The use of busywork created a cyclical pattern of marginalization of students of color in science class with Justice. The few students who disengaged from the busy work drew the teacher's attention away from students like Justice who wanted to learn. Unable to get help during class, Justice had to choose whether to meet with the teacher after school or proceed without the help she needed. The teacher's preoccupation with disengaged students resulted in more busywork while both motivated learners and disruptive students struggled with class. While the decision to use busywork may not be racist in origin, the outcome of excessive reliance on low cognitive level work in a majority minority classroom serves to marginalize those students of color.

Role of Science Teacher Education

Teacher education must help prepare teachers that are able to identify practices that are oppressive when applied directly in classrooms with high numbers of student of color. In addition, teachers must be prepared to teach in racially diverse classrooms. As shown by the youth, the science investigations must support the interests of youth. Deelilah found the pond water investigation interesting but not memorable. In contrast, the YPAR group chose to teach food and nutrition, a topic of relevance for youth. That is, teachers must be able to gather student input and have the tools to build meaningful lessons that address student needs and curriculum goals. For example, the actions taken by the youth to teach their peers in ways that emphasize experiential learning grounded in real life issues speaks to the new science framework and the

Next Generation Science Standards (NGSS, 2013). In terms of experiential learning, the youth supported the focus of the NGSS on developing science practices. The youth included laboratory investigations that enabled their peers to use scientific practices to investigate the nutritional value of the foods they eat.

The practices the youth employed in the YPAR project arguably parallel the practices found in *A Framework for K-12 Science Education* (NRC, 2011). The framework outlined the following eight practices of science and engineering:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics, information and computer technology, and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

The parallel in practices is an important consideration that shows how youth are able to actively engage in investigations. To be clear, the YPAR study is a sociocultural investigation of science education, not a science or engineering investigation. Yet, the youth demonstrated that they hold the capacity to engage in the practices essential to STEM fields by formulating their investigations to identify a problem and carryout an appropriate research protocol complete with analysis and reporting of their findings. The youth used evidence to argue for more equitable learning opportunities. The used digital technology and developed solutions that supported their STEM trajectories and for their peers. But when compared to the science narratives, their

experiences were largely void of opportunities to engage in the very practices espoused by the framework that need to be prominent in the science classroom. Instead, deficit narratives and institutional racism limited opportunities for the youth of color to have rich learning experiences utilizing the very practices they so expertly used in the YPAR project.

Also, the activities chosen by the youth for the teaching unit were explicitly selected so that their peers could engage specifically in science and engineering practices. While the youth did not consult the framework, the activities reflected the practices they wanted in their science learning opportunities. The youth selected a nutrition video game for their peers in lesson 1 so that they could access technology as included in the practices. In the second lesson, the youth emphasized the need to include an investigation as advocated in the practices and provided their peers with the food test lab activity. In the third lesson, the youth asked their peers to prepare a healthy menu. In essence, the activity required of the groups to engage in argumentation as to why the food items were deemed healthy options before the youth leading the lesson. And, upon receiving approval of the food items as healthy, the youth preparing the meal designed a solution for better health. In fairness to the youth who are not trained educators, the incorporation and implementation of the activities is guided by what is lacking in their science learning opportunities instead of addressing the framework with fidelity. For example, the inclusion of the computer-based activity was largely a response to access issues for youth of color rather than an invitation to vet the merits of the video game as related to scientific understanding of nutrition. The practices that the youth included in the teaching unit maybe be open to critique, but the emphasis is on the fact that these practices were not typical of the experiences in their schools. The youth-created teaching unit is a clear message that classroom science teachers need support

to better implement the science and engineering practices in their lessons particularly in schools with large percentage of students of color.

In addition to the practices, teachers will need support to connect youth interest to curriculum standards. The youth-created unit raised questions regarding the implementation of the NGSS by teachers in the classroom. The work of the youth invites a conversation that asks how can NGSS standards connect to the issues raised by youth such as the quality of school cafeteria food, options for food at home and in the community, and the way food choices impact the health of the community members.

If we examine a specific NGSS standard for middle school students, we find the following language:

> "MS-LS1-k. Develop a model to support the explanation that within an individual organism food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy." (NGSS, 2013)

In the standards language, the key terms are highly scientific. The language itself is not surprising but there is a notable absence of the concerns of the youth around food and nutrition issues as expressed earlier. *A Framework for K-12 Science Education* states that the new framework is intentionally broad in scope, and therein lays the opportunity to connect to the concerns of the youth (NRC, 2011). The *Framework* explains that the details are left to the standards developers but also those responsible for implementation in schools. The example of the youth-led food and nutrition unit born out of their concerns invites us to consider the following questions. How is it that the food choices made by youth can support the growth and development of their bodies? Likewise, how can the impact of food choices be understood

through a richer conceptual understanding of the chemical pathways of digestion? In this example, what the youth are doing suggests that we must consider how to support teachers to make a connection between the standard and how food choices issues in a way that is both relevant to the learners and rigorous in conceptual understanding.

The *Framework* is attentive to the growing diversity of students and calls attention to the need for teaching to respond to the needs of all students:

> "The goal of educational equity is one of the reasons to have rigorous standards that apply to all students. Not only should all students be expected to attain these standards, but also work is needed to ensure that all are provided with high-quality opportunities to engage in significant science and engineering learning" (p. 2-4).

There is an underlying tension despite the awareness of an increasingly diverse student population. The tension is that the *Framework* and subsequent NGSS are written from a normative view of science. To be clear, I am not contesting the laws and theories, discoveries or the practices of science. What I am stating is that the corpus and history of science as presented in our schools come from a majoritarian perspective embodies as the institution of Western science. Going one step further, I will point out that science is historically entrenched and authored from the White male point of view. As a result, we must recognize that the science framework and the actual NGSS and consequently classroom science instruction are an extension of a single dominant narrative that is not representative of all people. Ikemoto (1992) wrote about forced medical treatments on women of color and argued that standardizing the White female experience as normative effectively silences women of color. If we apply Ikemoto's understanding to science education, we see that the framework and standards were not written

with race, gender, class or cultural differences in mind. These social markers are not integrated in ways that honor the lives, stories and experiences of non-White students in the NGSS.

To illustrate my point, Chinn (2006) laments that Native Hawai'ian students underperform on standardizes exams when compared to their non-Native peers and looks to the different cultural ways of understanding the natural world as the primary problem. She starts with the arrival of missionaries from the mainland US and the efforts to move toward a monoculture specifically naming schools as the vehicle for disrupting the Hawai'ian culture. And thus, the problem is not the inability of the Native Hawai'ian students to understand and do science but an incompatible curriculum that does not recognize and honor the Native Hawai'ian relationship to the natural and physical elements. Chinn (2006) provides a powerful example of the connectedness between the Native Hawai'ians and nature describing the relationship between the blooms on the wiliwili tree and the sea through a proverb that states "*Pua ka wiliwili nanahu ka mano*" (p. 373). Natives understand that when the tree blooms, it is unwise to enter the water for the sharks may bite. The proverb eloquently captures the significant relationship between the land and sea as well as the relationship of people to nature in Hawai'ian culture. In contrast, a Western understanding may explain that the tree blooms happen to coincide with the shark mating season during which frenzied behavior could result in bites for anyone entering the water. While Chinn does not isolate the authors of the mandated curriculum, it is clear from this example that school science is stripped of the social, cultural and historical contexts familiar to Native Hawai'ian students.

On the other hand, trying to represent the diversity among students into the framework and standards document would be an overwhelming and presumably impossible task. This leaves us with a conundrum. How can we support science teachers and curriculum developers to uphold

the new *Framework* and NGSS developed from a dominant monocultural understanding of science in non-oppressive ways that account for racial, class, gender and cultural differences among students? As shown in this project, a fundamental shift in teaching philosophy toward empowering and liberatory pedagogies offers hope that youth can engage in science in meaningful ways. Therefore, the classroom must become a space in which learners are recognized as individuals with thoughts and concerns and have the right to express their ideas. We need to facilitate science teacher preparation that: (1) allows for free expression of youth concerns; and (2) supports the teacher to connect youth concerns to the curriculum. Rather than a top-down approach, the science classroom becomes a bottom-up space.

Including Youth in Educational Research

I advocate for the inclusion of youth in research of school learning. Youth participation in research expands on current notions of who can do research and ultimately who can contribute to decisions in education. This presents a departure from traditional research where youth were most often subject of research, not producers of research. While the youth may not hold the same credentials as academic researchers, this investigation demonstrated that youth of color have unlimited capacity to participate in high-level research and learning. The youth were also articulate in new spaces with new audiences advocating for equitable STEM opportunities.

A less common facet of research but central to YPAR (and PAR) is the action component in which participants actively used evidence from research to transform social conditions. Arguably, the youth acquired skills that can be applied in different contexts where oppressive conditions exist. Furthermore, YPAR was humanizing as a research methodology (Irizarry & Brown, 2013). According to Irizarry & Brown (2013), YPAR creates "a space in which individuals and communities can work collaboratively toward more fully realizing their human

potential" (p. 65). YPAR empowered youth to challenge the inequities faced in their everyday lives. YPAR valued the youth as experts of their lived experiences from which knowledge is gained and used to name and eradicate oppressive structures. YPAR enabled youth to enter conversations that might otherwise be inaccessible. Who better than the youth guided by lived experiences and a critical eye for inequity to contribute to our understanding of racism in schools and to fight for transformation.

YPAR as Critical Race Methodology

An important contribution of this dissertation is to present a concrete example of Critical Race Methodology (CRM) that is situated in science education. My study explicitly challenges race and racism through YPAR in the science education literature. Critical Race Theory provided a lens for this dissertation through which to critically examine the world to understand and expose how racism is enacted. But, as embodied as a tenet of CRT, there must also be action toward social justice. Solórzano & Yosso (2002) stated:

> We define critical race methodology as a theoretically grounded approach to research that (a) foregrounds race and racism in all aspects of the research process. However, it also challenges the separate discourses on race, gender, and class by showing how these three elements intersect to affect the experiences of students of color; (b) challenges the traditional research paradigms, texts, and theories used to explain the experiences of students of color; (c) offers a liberatory or transformative solution to racial, gender, and class subordination; and (d) focuses on the racialized, gendered, and classed experiences of students of color. Furthermore, it views these experiences as sources of strength and (e) uses the interdisciplinary knowledge base of ethnic studies, women's studies,

> sociology, history, humanities, and the law to better understand the experiences of students of color. (p. 24).

We developed a research-based approach consistent with CRM by employing YPAR to interrogate the race and racism in science opportunities and experiences of the youth participants. For example, race was central in the comparative studies between schools as seen in the difference found in the curriculum guides and school observations. The youth challenged who can do research by engaging YPAR to enter the world of academic research and conference spaces; locations that are rarely open to youth. The liberatory nature of CRM and YPAR was seen in the evolving narrative that youth voice does not matter to one filled with purpose and belief in their ability to bring forth change. For example, the youth were empowered to lead a teaching unit for their peers to challenge the racism in school science whereby youth of color were more likely to be subjected to disengaging instruction also referred to by the youth as busywork. The youth, especially Justice, demonstrated awareness for the intersectionality of racism particularly with class as she frequently pointed out financial challenges in her own life. Justice used her experiences with racism and class status as a strength that fueled her desire to want to make a difference and seek a STEM trajectory. As a group, we looked at the history of racism as well as current events to understand the systemic oppression of youth of color. Especially poignant during the project was the developing story of Trayvon Martin, an African American teenager gunned down because a neighborhood watchman found him to be "suspicious". The youth identified with their fellow teenage peer who because of racial identity was incorrectly judged as a problem. Applying a CRM allowed us to clarify the ways race and racism systemically denied opportunities and support for youth of color to realize their STEM

aspirations. CRM also enabled us to take transformative actions with the goal of supporting the STEM aspirations of the youth and to fight racism in school experiences.

Added Benefits of YPAR

In addition to the aforementioned benefits, YPAR impacted the personal growth and development of the youth. Youth exhibited growth in confidence over time through participation in the events leading up to and the workshop presentation itself. Specifically, the youth gained confidence to speak before large audiences undergirded by the important purpose of their work. Planning and presenting to a 200 member audience with several peers from across the state posed a large challenge. Yet, the youth had the courage to press forward with the hard and unending work of transforming opportunities in the face of oppressive structures.

The youth motivation and commitment grew over the duration of the project. In addition to our regular weekly meeting, the youth extended themselves to be available driven by their wish to take action. For example, I wrote in my field notes just over a week prior to the workshop presentation, "they wanted to prepare a good workshop and Justice said she could probably meet on Saturday. Deelilah was also available but Lil c was heading out of town. We made plans to meet given that we have a week to pull everything together." I frequently receive text messages for the youth asking whether I am coming to join them at the youth center so that we can meet and work on our next task. The youth felt like they not only had impact through their work but also had purpose. In a text message presented here verbatim without grammatical changes, Justice wrote, "Thanks so much for taking your time out of your life to do with us I really appreciate it I'm glad that i get to something that will keep me out of trouble".

Challenges of YPAR

The implementation of YPAR as an approach to research comes with challenges. Here, I describe three of the challenges encountered in this specific project. The first challenge was coordinating with a group of youth to arrange meeting times for group work. The second challenge was the departure of the teen director at the youth center, a strong ally for our project. The third challenge was to adopt a mindset that delays are inevitable when engaging YPAR.

Understanding the Busy Lives of Youth

As the name implies, youth participants are critical to the success of YPAR. Working with youth also comes with challenges. To be clear, I describe the challenges of working with youth to provide an accurate representation for anyone considering YPAR in their work. As a researcher, I absolutely understand and respect the extraordinarily busy lives of the youth participants who so graciously worked with me over a full year. I am forever grateful and indebted to my participants and in no way intend to disparage the youth and their contributions.

One thing I learned quickly was that I had to be very flexible in finding times to get the group together for a working session as a voluntary project. Despite making several attempts to find a weekly meeting time, we often changed at the last minute. The reasons were numerous including constantly changing work schedules for the youth who were also junior staff members at the youth center. The lives of teenagers are also demanding of time and often times complicated. We had days where youth participants had to rightfully prioritize their school obligations and finish homework or study. Some days brought family commitments. At other times, the youth center had special programs for teen members pulling the participants from the YPAR project. Some participants were also away from the youth center after school for periods of time involved in extracurricular activities such as school sports. But, in the end, through give

and take, the youth worked with me to find other times to meet. There were different days when Justice, Lil c, or Deelilah each returned to the youth center just so that we could meet even though they had already gone home.

Another lesson learned is to anticipate that there will be delays and frequent changes to even the best laid plans when using YPAR. In addition to youth availability to meet and the scheduling conflicts with youth center programs, the project may also necessitate a change in plans. The YPAR investigations may take more time than planned to gather the necessary data. Extra time may be needed to learn research techniques. New developments that arise in the course of YPAR investigations may demand more time and attention. For example, the planning and implementation of the food and nutrition unit took longer than predicted. We had weeks where some group members were not able to meet so parts of the lesson planning got delayed. Furthermore, the relatively limited teaching experiences of the youth meant that I needed to do more scaffolding for the lesson planning and set aside more time to work. We also had find three consecutive weeks to deliver the three lessons for continuity.

Loss of a YPAR Ally

During the YPAR project, a change in teen directors at the youth center introduced a different set of challenges. The original teen director at the youth center when the YPAR project commenced was an important ally introducing me to youth who ultimately joined the project. She was extremely supportive of the project and often started rounding up the youth for our meeting as soon as she saw me enter the teen room. In fact, there were several occasions when I dropped by to say hello, update the teen director on our activities or leave reminders for the youth and she started to round up the youth even though we were not scheduled to meet. We also

had prior interactions leading up to the project. Alas, she was presented with a new career opportunity and made the decision to depart the youth center.

In the following days, the youth center hired a new teen director. After a transition period, I introduced myself to the newly hired teen director. I wanted to share an overview of the project and let her know which of the teens were in my participant group. Perhaps my delivery was flawed, but I immediately sensed I posed a threat to her as the new teen director working to establish herself and develop the programming for teen members. Her reaction indicated that I did not clearly explain the project. I tried to convey that the YPAR project goal was transforming opportunities for youth to pursue STEM trajectories. The new teen director responded that she already had a college preparation program planned. She asked if I wanted to lead the college preparation program for all of the teen members. I respectfully declined and stated that I had an invested and committed group of youth working with me. Our rocky start reminded me of the importance of building relationships with people in the YPAR project and on the periphery.

I made several attempts to facilitate communication so that we could build a working relationship with little advancement. In fact, we probably did not have a relationship as epitomized in the follow entry in my field notes from a project meeting with Justice, Lil c, and Deelilah that was cut short:

> It was around this time when the teen director entered the room looking for the girls. She asked them if they remembered that they had Keystone Club in a few minutes (6pm). The girls asked if they could make it up but that wasn't a satisfying answer for the teen director. In a huff, she said something about she'd pull their folders for them. Sensing the tension, Justice said they'd be there in ten minutes. Then, the teen director let me know she 'wished I had known you were meeting with them' and glared in my direction.

After the teen director left the room, the youth apologized to me for the abbreviated session. The manor in which the teen director handled the situation unfairly placed the youth in a compromising position.

Rather than belabor the point and describe other incidents, I turn to a positive development with the teen director. The teen director had independently arranged for a group of teens to attend the same student leadership conference described in Chapter 5. The youth presented their workshop with the teen director and peers in attendance. Following the conference, the teen director was more positive toward the project. I enjoyed more pleasant interactions with the teen director in the days that followed. She even drove the youth to and from the local university for their virtual presentation for the academic conference. I was at the conference and the youth needed to be at the university to access the technology for their presentation. I learned upon return from the conference from Justice that the teen director gave them "attitude" on the way back to the youth center following the presentation. For this, I felt extreme guilt for placing the youth in another compromising situation because of their willingness to participate in the YPAR project.

I consider my relationship with the new teen director as a learning opportunity. First, I reconsidered my approach to the initial conversation to take into account how my message might be received and to consider the circumstances of the person on the other end. Second, I need to work *with* people that are not necessarily central but nonetheless important to the project in the same way I do with the youth. Often, I made requests of the teen director to accommodate the project schedule and events. Perhaps, my requests became demanding despite my efforts to work around the programming and work schedules at the youth center. Third, I need to be more purposeful to avoid putting youth in compromised situations if I intend to humanize research.

Malcolm Getting to College

I return to Malcolm's story that I started in the introduction of Chapter 1 to make a point of the obstacles that continue to appear along the STEM pathways especially for youth of color. Malcolm's effort to getting started in college was nearly derailed by a new set of equity issues that work to deny STEM aspirations. The obstacles included financial barriers, educational hurdles created by both the high school and college, and barriers from the government and banking institutions. Malcolm's journey was full of hopes and dreams but riddled with frustration.

For youth of color, forces outside of science learning spaces often complicated the pursuit of STEM aspirations. As described in the introduction, Malcolm did not have the support from those who are responsible for assisting students along their chosen trajectories. For example, for an aspiring engineer to not take a science course in his final year of high school is atypical and a result of not getting adequate guidance from the guidance counselor. When I asked whether he had discussed his interest in engineering with his guidance counselor, Malcolm indicated that they only ever met to make sure his schedule is complete (Field notes, 2012). He never spoke with his guidance counselor about graduation, career aspirations, college applications, college entrance exams, or financial support for college. Malcolm's dream to study engineering or kinesiology was not supported before or after graduation by the high school.

A week after graduation, Malcolm approached me at the youth center to ask if we would meet to talk about college. I gladly accepted his request and began what became a series of meetings and a rough journey for Malcolm to enter college. In this way, Malcolm granted me a close look at the obstacles in his way toward becoming a kinesiology major. Thus, my role was to support and in many cases be an adult advocate acting on behalf of Malcolm to help navigate

the series of barriers he faced. I was intimately involved as both advocate and researcher. I frequently drove Malcolm to the campus of the community college and other locations, answered questions and offered advice regarding navigating the college-going process, tutored Malcolm in math to prepare for his placement exam, and worked to support his aspirations within my capacity.

In our first meeting, I probed Malcolm on his interests. Sports and specifically basketball were a major part of his life and interests. This was evident in his work at the youth center as both a coach for the middle grades team and coordinator of the activities in the gym. I watched basketball practice on several occasions and witnessed Malcolm's passion working with youth to help them become better skilled at the game but also emphasizing sportsmanship. On a Friday afternoon, I watched Malcolm preparing the gym for a Saturday morning game. He recruited players from the team to line up chairs for both teams and set up the scorer's table as he swept the entire floor. The youth were learning lessons in responsibility and Malcolm displayed his deep investment in the game he loves. Through our conversation, he talked about what he would really love to do is coach basketball eventually at higher levels. He also hadn't given up hope of playing collegiately. Malcolm investigated how he could use a college education to further his interest in coaching basketball and is broader interest in athletics when he discovered kinesiology.

In terms of options for getting into school, Malcolm's choices were limited by the timeframe for starting the application process, his academic record and financial limitations. We had our initial conversation about college in June, well after decisions to attend four-year institutions were being finalized for recent high school graduates. The opportunity to apply for a four-year college had passed for now and his overall grade point average was below the average for the closest public university. The cost to attend college was also a concern for Malcolm and

his family and he did not want to take on a loan. Starting college at a community college and getting a two-year transfer was the best option available for Malcolm given the circumstances. The program allowed students to earn an associate's degree in two years with the option to apply for transfer to a four-year institution. Malcolm would be able to start school sooner, establish a new academic record that hopefully would make him more competitive at the time of transfer and live at home alleviating some of the financial concerns.

The FAFSA was the first obstacle to accessing both funding and college for Malcolm. Three options are available for completing the application process (FAFSA, 2013). Two options require access to technology including the Internet. The third option was to call a toll-free phone number to request a paper application. The FAFSA website explicitly recommends using the fully online option thus built on the assumption all applicants have access to technology in what amounts to be a potential equity issue. I borrowed a university laptop and set up a wifi hotspot so that Malcolm could complete the FAFSA online. During the process, we had to stop and start a few times so that his father could locate the tax return information requested by the FAFSA. Malcolm entered all of the required information and with his father's permission selected to have the Internal Revenue Service provide tax information directly to FAFSA. In my field notes, Malcolm grew frustrated with the multiple times he had to sign in and sign out depending on what new piece of information was requested to the point he almost stopped.

Once Malcolm completed the FAFSA, he applied to the community college. Again, this process was completely online. He filled out the online form and instantly was rewarded with a letter of acceptance. While the application process was extremely efficient, Malcolm would later find out that simply being accepted into the school did not insure that the rest of the steps would be so easy.

Malcolm applied for a local promise grant that would pay for two years of college only to find that the deadline had passed for fall semester. He completed the application online to receive funds starting with the following spring semester. The promise grant was available to any graduate in the local K12 school district that met eligibility requirements. The grant stipulated that a student who had attended school since the 6th grade until graduation received the most funding. Students enrolling in the district after 6th grade received incrementally reduced funding. Malcolm attended schools in the district for his entire K12 education and was qualified for funding. But prior to our investigation of how Malcolm might pay for school, he was not aware of the grant. According to Malcolm, his guidance counselor never presented the grant opportunity nor was it well advertised in the high school despite students in his school were the target audience. The other stipulation was that students must have completed the Free Application for Federal Student Aid (FAFSA) in order to receive promise grant funds.

Malcolm arranged a meeting with an academic advisor so I offered a ride to the community college. While on campus, he also planned to take care of various matters and be ready to start classes as soon as funding was awarded. During the visit, we learned that his FAFSA was not processed, yet. The hold up was with the failed transfer of his father's tax return information. Later, Malcolm re-verified the information he had provided with the FAFSA online application. The financial aid office provided an 800 phone number to contact the IRS for a tax transcript. Malcolm asked but they could not accept a copy of the tax paperwork his father had completed.

Malcolm also learned that incoming students needed to take placement exams in math and language arts. The assessment center on campus provided sample questions and other resources to prepare for the exams. He looked over the practice questions and decided to take the

placement exam. His language arts scored were acceptable but was told he'd have to retake the math portion. A follow up meeting with an academic advisor revealed Malcolm would have to spend at least a year taking courses in the Basic College Skills sequence suggesting that his high school had not prepared him to start a college level program immediately.

After his FAFSA cleared, Malcolm learned that he could register for classes but needed either a credit card or bank account to secure his spots in the classes. Malcolm had neither. His father also did not have a credit card. I accompanied Malcolm over the next several weeks on what seemed like a wild chase so that he could enroll for his first semester of college. We visited the on-campus branch of a local bank to find out how to open an account. The bank asked for a government issued photo identification card such as a driver's license. Malcolm did not have a driver's license or permit. In order to get a permit or take a driving test, there were fees for which Malcolm did not have the cash on hand. By law, he had to get the permit first and wait 30 days before he could take the driving test meaning he would incur two fees despite being old enough for the driver's license. Malcolm also learned that he would need a social security card to get a driver's permit. His mother was unable to locate his social security card. We went to the social security office to apply for a new card. The social security card would be sent in two weeks but luckily they provided a print out as a temporary form. Malcolm started backtracking to get all of the necessary parts to open a bank account and finally enroll in classes.

Throughout the saga of getting Malcolm enrolled, there were many obstacles that could have easily taken him off the college pathway. In this case, money was the source of power and privilege working against Malcolm. The technology requirement to complete applications is an access issue for some families unable to buy a computer or pay for Internet service. I provided several rides because he lived in a single parent home and wasn't always able to get a ride from

his father. As noted, Malcolm did not have a driver's license to get places. Even if he had a license, he did not have a vehicle at his disposal. The driver's permit came with a fee requiring cash. All of the obstacles had the potential to take Malcolm off the STEM trajectory. Negotiating the obstacles and completing all of the steps required additional knowledge and money.

Conclusion

The systematic nature of racism must be acknowledged in education circles if we are to truly improve the opportunities to learn science for students of all colors. The work of the youth exposed how science opportunities offered by different schools disadvantage populations of color. Students at Murphy High School, with a majority minority population, are far more limited in the science courses they can choose to take compared to Smithers High School, a predominantly White campus. Despite years of rhetoric purporting to make "science for all", the evidence points to increasingly disproportionate representation for populations of color in STEM fields (Frehill, DiFabio & Hill, 2011). As the youth have done here, we must look beyond science education to the social structures that advantage dominant populations at the expense of populations of color. The point is not to dismiss research in science education but to advocate for connecting scholarship and solid pedagogy with the sociopolitical context in order to better serve the youth in our schools. Specifically, research must interrogate the ways school structures work in a racialized society and the implications for all learners. In places where race becomes a tool to oppress learners, corrective action must be swift and transformative.

As a researcher, using YPAR had transformative value for the youth participants, which in some ways sets the methodology apart from most other approaches. By committing to humanizing research, my goal is to insure my work is done with care and love for each participant. When the time comes to conclude the research partnership, the youth participant

must be better off than before the start of the project. The youth participants in this project started the project arguing “the schools aren’t gonna listen”. Part way through, the youth softened their stance to “it might not change but it’s worth trying”. By the end, the youth declared “we accomplished a lot!”

Other than Deelilah who has always aspired to enter law enforcement, the rest of the youth are still pursing STEM aspirations. Regardless of STEM or non-STEM aspirations, the youth have experience using tools to uncover racism in school experiences. The youth also have the capacity to advocate for their learning. Recently, Lil c pointed out an example of being marginalized. Lil c’s guidance counselor was building her class schedule for her senior year. The counselor told her she did not need a math class but Lil c knew better. What had happened to Malcolm and being steered away from taking science his senior year was still standard practice at Murphy only this time in math.

Malcolm as of the end of this investigation was in his first semester of attendance at the community college pursuing his kinesiology two-year degree so that he could transfer to a four-year college. He also received full funding to pay for the first two years of his college education without needing to take out student loans.

Justice will finish her junior year of high school in the coming weeks. She has been studying to take the ACT college entrance exam. Very recently, Justice spoke of her new interest in looking into a nursing career. She is also researching the option to attend a Historically Black College & University (HBCU) after high school.

Lil c will also finish her junior year and much like Justice has talked recently about a career in nursing. She mentioned moving to a large Southern US city to attend an HBCU institution. Lil c boasted recently that she has never received a grade point average (GPA) on a

report card below 3.0 and is working to maintain her streak. Due to personal matters that kept her out of school too many times, she is attending credit recovery classes after school to stay on track.

Deelilah will finish her freshman year of high school. She told me that she will have an opportunity to take a math placement test at school so that she can be in the right math class for her abilities. Being the youngest member of the project, another benefit is the way she has been absorbing knowledge from her peers. We had a discussion about college applications and how grades from freshman year count toward the cumulative GPA. Along with the inequities exposed through YPAR, Deelilah leaves with a strong awareness of the inequities that lie ahead but with strategies to navigate some of the pitfalls.

Caesar will finish his sophomore year. Due to his commitment to other extracurricular opportunities, I have not spoken with him at length since he reduced his participation. I hope that he steps away with at least a critical eye toward the inequities in school opportunities.

Finally, I depart having been fully immersed in the project and invested in the lives of the youth over the last year. I feel that I am leaving with far more than I have given the youth. The most important benefit I takeaway is the hope that the youth are equipped with the tools to call out racism and fight inequity anytime they find them.

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