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Lifting the Veil: A Critical Post-Intentional Phenomenological Action Research Study of How African American Students Experience Science

Gina Martin

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LIFTING THE VEIL:
A CRITICAL POST-INTENTIONAL PHENOMENOLOGICAL
ACTION RESEARCH STUDY
OF
HOW AFRICAN AMERICAN STUDENTS EXPERIENCE SCIENCE

by

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DEDICATION

To Myra Lee Hoffman, Mom

Thank you for teaching me that love is patient and courageous.

I cannot see you, but I know you walk with me.

*“The moment we choose to love we begin to move
toward freedom, to act in ways that liberate ourselves and others.”*

bell hooks (1994, p. 298)

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ABSTRACT

Research asserts the assimilationist nature of traditional science classroom practices undermines African American students' intersectional race and science identity. Driven by a problem of practice embedded in the racialized system of science education, this study integrated action research with an innovative critical paradigm to explore how phenomenological data can transform practice. This post-intentional approach relies on experiential, phenomenological data of how African American students experience science to provide a critical analysis of instruction that leads to a change in science pedagogy. Qualitative interviews documented African American students' experiences with science and an observation journal documented the resulting intervention. A post-reflexive journal ensured data collection and analysis remained centered on student experience. Two new findings, teacher's preconscious and equitable dialogue, emerged and informed an intervention that enhanced African American students' intersectional race and science identity. Student voice, a component of equitable dialogue, is essential to promoting African American students' science experiences and sense of opportunity in science.

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CHAPTER 1

INTRODUCTION

In 2001, I was hired as a physics teacher for a high school in suburban Maryland, the same school I graduated from more than a decade before. The year I graduated, the student population was predominantly White, and there were no Black science teachers. Throughout high school and later, in my college-level science courses, I was often the only African American student in my classes. My parents had always expected me to excel in school, regardless of who was in the classroom. For them, education had been an escape route from economic insecurity and the only hope for not returning to it. When I was hired, I became—and still am—the only African American science teacher in this school. I perceived these circumstances as normal, and I accepted the status quo. There seemed to be one way of learning and knowing science. It did not occur to me that my experiences and perceptions reflected deep and complex inequities in education.

Three years ago, in my 27th year of teaching, Andrea (pseudonym) arrived in my classroom. That year, in that class, Andrea was the only African American student. Her discomfort during class was palpable. Every day Andrea looked at me with widened eyes that seemed to say, *do NOT call on me*. It seemed to me that Andrea was not interested in working with other students; she would not speak to them, not even to say hello. During group work, she would put her forehead on her desk and her work on her lap. I privately redirected her, asked her to try, and showed her what I wanted her to do. Nothing changed. Despite earning all As in physics, Andrea was not interested in physics. I

believed I was doing my best to help Andrea. I tried different combinations of students for group work, hopeful that she would find something or someone engaging. I complimented her work. I encouraged her to share her ideas with other students. To me, the curriculum seemed as culturally and racially neutral as any subject could be. The students had done group work before, and they knew that at the end of every unit, there would be a test to assess their knowledge.

I assumed that if I had learned to be successful in a world of limited diversity, then Andrea could too. I believed that since we shared the same identity, I understood what Andrea was experiencing and how to address it, yet I was not successful. I could not figure out what was wrong, and I was frustrated. Now, three years later, Andrea still crosses my mind, and I realize that my acceptance of a narrow set practices restricted my ability to engage and allow her to find relevance in science. I failed to recognize that Andrea's experiences and the meanings she attached to them could produce another reality, and I missed the opportunity to understand it.

Problem of Practice

When I taught Andrea, I believed that neutral science practices and curriculum leveled the field of opportunity for students and encouraged persistence in science. Andrea's response to the way I taught signaled I was wrong. What I believed were race-neutral practices were assimilationist ways of teaching. In assuming there was one way to learn and know science, I expected students with other perspectives to assimilate. The problem was my misunderstanding of the importance of students' experiences in the context of science and how they influence perceptions and learning. Even though it is the teacher's responsibility to bridge and leverage students' culture with learning (Counts,

1932; Ladson-Billings, 2009), as I reflect on my teaching, I realize that I believed I had done this, but I had not.

Erikson (1968) explains that identity confusion arises from a discordance among identities. Du Bois (1903) extends this idea to the experience of living as an American of African descent. Each American of African descent internalizes the struggle between an individual sense of identity and a collective, racialized identity differently. Du Bois (1903) used the symbolism of wearing a *veil* at all times to explain this divide. Research suggests students' perceptions of classroom experiences contribute to the development of their academic identities (Hazari et al., 2015). When students believe their voices and experiences are not valued or respected, they fail to identify with classroom learning, and the veil becomes impossible to lift (Ladson-Billings 1995). Negative experiences, in conjunction with deserts of diversity in advanced math and science classes, send a message that math and science are not congruent with an African American identity (Wang, 2013). In critically examining my teaching, I found that my acceptance of the status quo reinforced underrepresentation in science (Merriam & Tisdell, 2016).

Now, I realize that even though I am an African American in science, I cannot assume I experienced science in the same way as my African American students. Despite 27 years of teaching, I realize that my practice was neither demonstrating value for nor nurturing the intersection of race and science. My acceptance of my educational experience as the norm resulted in classroom practices that narrowed African American students' opportunities to engage with science. These assimilationist, color-blind practices did not make science relevant; instead, they sterilized it. By removing race and culturally based experiences from physics, I devalued their worth, sent the message that

the wealth of experience students bring to the classroom is irrelevant, and kept the veil lowered. In accepting and perpetuating the norms and status quo of science, I had contributed to inequity in science. Now, it is clear why Andrea never engaged with physics. I restricted her opportunity to find something with which she could engage.

Background

In comparison to White Americans, who make up more than 50% of all science, technology, engineering, and math (STEM) bachelor's degree recipients, Black Americans make up 9% of STEM degree recipients (National Science Foundation, 2012). STEM degree holders enjoy greater economic security because they have higher earnings than non-STEM degree holders and no shortage of opportunity (Noonan, 2017). Despite projections that the STEM field will be the fastest-growing career field through 2024, there are not enough Americans graduating with STEM degrees (Noonan, 2017). For example, every college graduate with a computer-related bachelor's degree will find seven jobs waiting (Noonan, 2017). Notwithstanding the opportunity available in STEM, Black Americans are less likely to obtain STEM degrees and almost three times more likely to live in poverty than White Americans (Semega et al., 2017). If individuals with STEM degrees have greater economic security, then the STEM interests of African American students would address issues surrounding STEM diversity and economic equality.

If the country needs more STEM graduates, and if students who take STEM classes in high school are more likely to pursue STEM careers (Franco et al., 2012), then science education researchers should focus on science education practices. The idea that more math and science exposure for Black high school students is better is incorrect.

Instead, research indicates that the type of high school science experience is more significant to Black students' desire to continue in STEM than for White students (Wang, 2013).

Classroom experiences that fail to engage or outright discourage African American students will dissuade them from pursuing science (Wang, 2013). This research suggests that both neutral and negative experiences will reinforce the veil. However, experiences that nurture African American students' interests in science will encourage students to pursue STEM careers (Hazari et al., 2015). As a physics teacher, I am situated to challenge inequity and underrepresentation in STEM through a shift in my practice, specifically by engaging in action research. In the next section, I will outline the theories that shaped my study by informing my understanding of how race and education intersect to form a unique reality for African American science students.

Theoretical Framework

By introducing theory early in this chapter, I intend to provide an orienting framework for understanding my approach to exploring the phenomenon of how African American students experience science. Rather than exploring theories that frame and act as lenses for a study, post-intentional phenomenologists refer to the theoretical framework as a description of "theories I want to think with" (Vagle, 2018, p. 142). This way of embracing theory allows me to remain open to other theories that emerge throughout my research (Vagle, 2018). For now, Critical Race Theory (CRT), Black existentialism, identity, and curricular disciplines are launching points for conversations that emerge from my data (Vagle, 2018). In Chapter Two, I will expand on the theories I introduce here.

The background literature I described earlier shows that African American students are not pursuing science. In my research of educational policy as it intersects with race, I found that historically, responsibility for the academic failures of African American students has been assigned to the students and their families. In one example, the 1965 United States Department of Labor report titled *The Negro Family*, sometimes referred to as the Moynihan Report, cited single-parent, African American families as the reason why African Americans did not find success in education. In another example, the National Education Longitudinal Study of 1988 suggested that Black, Hispanic, and Native American students are deficient in math and reading (Kaufman et al., 1992). Both examples ignored the role of historical, intergenerational, systemic racism by moving the responsibility for the academic failures of African American students from the American education system to the individual (Ladson-Billings, 2009).

My problem of practice demands a critical examination of race-related educational literature that results in action-based challenges to the racialized norms of science education (Bloomberg & Volpe, 2019; Herr & Anderson, 2015). The theories I have chosen to think with reject the idea that African American students are deficient. Instead, they center on how identity intersects with systems that limit African American students' opportunities in science. By limiting opportunity, Du Bois' (1903) veil becomes heavier and more difficult to raise. These theories explore how teachers' practices frame classroom experiences that contribute to a restrictive sense of opportunity for African American science students.

Critical Race Theory

Research states that race imbues African American students' science experiences (Crenshaw, 1989; Ladson-Billings & Tate, 1995; Tatum, 2017; Wang, 2013). Therefore, CRT, a theory of how social constructions of race have framed and informed American systems, is essential to my critical analysis of science education. As CRT is a broad theory, I have identified four components relevant to my study: racism as a norm, race as a social construct, intersectionality, and the counternarrative (Brown & Jackson, 2013; Ladson-Billings, 2013; Ladson-Billings & Tate, 1995).

In 1970, legal researchers theorized about the role of American law in reinforcing power hierarchies within systems (Brown & Jackson, 2013). As the researchers sought to understand how these hierarchies were formed, reinforced, and how they could be changed, they became the first official critical race theorists (Brown & Jackson, 2013). In his discussion of *Brown v. Board of Education*, critical race theorist Derrick Bell (1980) extended CRT to explain how racism has influenced education. Bell asserted that despite the abysmal conditions of the schools that served African American students during segregation, many African American students had received a culturally relevant education. An unanticipated outcome of the *Brown v. Board of Education* ruling replaced African American students' culturally relevant education with an assimilationist one, thus reinforcing racism in education as a systematic norm (Bell, 1980).

The concept of an assimilationist education is informed by Harris' (1993) conceptualization of *Whiteness as Property*, which addresses how race provides control, security, protection, and privilege for some groups and not for others. When education is seen as White students' property, White students have the privilege to access it, while

Black students are forced to assimilate or suffer marginalization (Harris, 1993). In classrooms where one set of experiences, usually those of White students, is considered the norm, racism is normalized. Without the privilege of a culturally relevant education, all students do not have the privilege to access education. Black students are pushed to the margins, where they internalize that education does not belong to them.

Race is socially constructed when the meanings attached to it determine acceptance into a social system (Bell, 1992). As a system in which people must interact, and in which personal and systemic understandings of race influence interactions, education is one example of the fluid relationship between the system and the individual that reinforces the social construction of race. In his autobiography, Malcolm X (1965) shared the story of his grade-school teacher who noted his exceptional intelligence and asked him about his career plans. When Malcolm shared that he wanted to be a lawyer,

Mr. Ostrowski looked surprised, I remember, and leaned back in his chair and clasped his hands behind his head. He kind of half-smiled and said, “Malcolm, one of life’s first needs is for us to be realistic. Don’t misunderstand me, now. We all here like you, you know that. But you’ve got to be realistic about being a nigger. A lawyer—that’s no realistic goal for a nigger. You need to think about something you can be. You’re good with your hands—making things. Everybody admires your carpentry shop work. Why don’t you plan on carpentry? People like you as a person—you’d get all kinds of work.” (X & Haley, 1964, p. 38)

I have included the full quote here because it exemplifies how broad social constructions of race, as embodied by teachers, reinforce the racial restrictions on opportunity for African American students. Even though *how* we understand race and *how* it influences

the education of African American students may have changed, we cannot deny the historical influence of racism in education.

The historical influence of racism contributes to African American students' sense of self as well. The theory of intersectionality describes how individual experiences at the intersection of multiple socially constructed categories inform a unique sense of self (Crenshaw, 1989). In Crenshaw's (1989) original paper, she explored how African American women were marginalized in conversations of gender because of their race and again in discussions of race because of their gender. Rather than isolating race and gender, Crenshaw (1989) explained how African American women's unique set of experiences at the intersection of race and gender shaped their reality and informed their identity. As perceptions of experience are unique, intersectionality challenges essentialism, or the idea that all African Americans have the same beliefs and behaviors (hooks, 1994). Without regard to how categories intersect, essentialism obscures and devalues the individual's unique reality (Ladson-Billings, 2013; Lynn & Dixson, 2013).

Crenshaw's (1989) initial work launched a reexamination of research that initially was not defined as intersectional but allowed for an intersectional analysis (Carbado et al., 2013; Cho, 2013). As a result, intersectionality theory has expanded to include "how fields of power operate and interact to produce hierarchy for any limitless combination of identities" (Cho, 2013, p. 386). I applied intersectionality to my study to explore how African American students experience science as it intersects with race. As fields of power, race and science become places where individuals are privileged or marginalized. If I were to examine science and race discretely, I would not be able to understand how their interaction produces experiences that inform identity construction and achievement

in science (Chase et al., 2018; Crenshaw, 1989). Therefore, intersectional theory is essential to my understanding of how African American college students experience science.

Earlier, I discussed policies that have historically contributed to the deficiency perspective of African American students. Today, the deficiency perspective continues to inform a dominant narrative of academic achievement that oppresses African American students' voice (Ladson-Billings, 2009). Students' voice is essential to my study because it provides a perspective that is different, or counter, to that of the dominant, deficient narrative. Ladson-Billings (2013) uses this African proverb to capture the importance of voice to the counternarrative: "Until lions have their historians, tales of the hunt shall always glorify the hunter" (p. 41). Without the voice of the lions, there is no counternarrative to the tale of the hunt. In the same line of thought, without the voice of African American students, there is no counternarrative to the study of race and science education.

Fortunately, the counternarrative is a methodological tool used by critical race researchers to uncover and illuminate the narrative of oppressed voices. Through interviews, I documented and illuminated a counternarrative of African American students' achievement in science that challenges the dominant narrative. This counternarrative is essential to challenging existing understandings of how science knowledge is learned and demonstrated.

In *Toward a Critical Race Theory of Education*, Ladson-Billings and Tate (1995) elaborated on Bell's (1980) application of CRT to education. Later, Lynn and Dixon (2013) produced *The Handbook of Critical Race Theory in Education*, which solidified

the application of CRT to education. These works explained how racism is an integral and permanent part of education, how education is deemed the property of White students, and the role of student experience with education as it intersects with race (Ladson-Billings, 2013; Ladson-Billings & Tate, 1995; Lynn & Dixson, 2013).

In this discussion, I have explained how CRT allowed me to recognize that being Black is significant in education when education is considered the property of Whites and that the experiences Black students have at the intersection of race and education, and not the students themselves, contribute to negative academic identities and underrepresentation in STEM. In the next section, I will elaborate on theories that facilitated my thinking about the significance of race and experience to a sense of opportunity and identity.

Existentialism and Identity

Existentialism is a philosophy with a foundation that exceeds the scope of this study. However, my research has revealed that existentialism, specifically Black existentialism, is necessary for thinking about how systems such as education limit opportunity. Individuals, existentialists assert, are free to define what it means to be human, both for themselves and for all of humanity (Sartre, 1956). However, Black existentialists argue that social constructions of race form systems that restrict individuals' opportunity to define what it means to be human (Fanon, 1952; Gordon, 2000).

The existential idea that individuals have an unrestricted opportunity to define both their existence and the existence of humanity is the point where Black existentialism diverges from existentialism and intersects with critical theory (Gordon, 2000). Whereas

existentialists expound on the individual's freedom of opportunity, Black existentialists challenge systems that impede African Americans' opportunity (Bassey, 2007). As I explored how African American students experienced science and how understanding that experience transformed my practice, I challenged the restrictive impact of science education on the opportunity of African American students. A restricted existence limits educational opportunity and the opportunity to define one's identity (Erikson, 1968; Sartre, 1956).

Identity is a sense of self that emerges from the meaning an individual assigns to experiences at the intersection of socially constructed categories, fields of power, and contexts (Cho, 2013; Crenshaw, 1989; Erikson, 1968; Tatum, 2017). An adult with a healthy identity can control their environment, demonstrate unity in who they are, and perceive their environment accurately (Erikson, 1968). Identity development during the adolescence is pivotal because it moves an individual from childhood to adulthood. During this time, if experiences conflict with or are irrelevant to an adolescent's racial identity, they will disengage from the conflicting identity (Erikson, 1968; Hihara et al., 2019; Tatum, 2017).

Identity development extends to academics too. When students perceive science as irrelevant to their identity, they disengage from it (Tatum, 2017). Therefore, experiences in the science classroom that preclude students from reconciling intersecting race and science identities will stop African American students from developing a science identity and persisting in science (Collins, 2018; Marsh, 2013; Tatum, 2017). Without experiences that allow students to conceive how science is relevant to their racial identity, they will not form a strong science identity (Collins, 2018). If they do form a science

identity, it will not be congruent with their racial identity and they will not persist in science or they will learn to compartmentalize (Garvin-Hudson & Jackson, 2018; Wang, 2013; Young et al., 2017). While some separation and compartmentalization of behaviors by context might have some benefits, compartmentalization of entire arenas of life, such as work or school, prevents the individual from demonstrating unity in who they are and undermines a healthy identity (Erikson, 1968; hooks, 1994). Broad compartmentalization is a defense mechanism to a perceived environmental threat (Tatum, 2017).

Understanding the importance of experience to identity formation clarified the importance of classroom experiences that nurture a congruent intersectional race and science identity. Pedagogy that claims to be color-blind or race-neutral, such as the pedagogy I practiced with Andrea's class, is assimilationist and devalues students' race-based experiences (Picca & Thompson-Miller, 2016). Practices that provide experiences through which students may construct a healthy intersectional identity of race and science are essential for student achievement (Garvin-Hudson & Jackson, 2018; Young et al., 2017). Consequently, thinking with specific curricular theories illuminated practices that nurtured congruent race and science identities.

Curricular Disciplines

Critical analysis of systems is essential to identifying and challenging patterns of marginalization and oppression (Merriam & Tisdell, 2016). In his discussion of social reconstructionism, Counts (1932) asserted that the development of critical perspectives was essential to equality. Counts (1932) argued passionately that it is the teacher's moral and ethical responsibility to help students develop and refine the skills necessary to analyze all systems, including education, critically.

Some science teachers believe, as I did, that personal experience is irrelevant to learning science and that there is one way of learning science into which students must assimilate (Banks, 2016; Picca & Thompson-Miller, 2016). Without a critical analysis of science or my practice, I readily embraced and repeated the assimilationist way I had learned science in my classroom. My practice reinforced an educational system that restricted opportunity for African American students in science. This study initiated my ethical and moral commitment to transforming my practice to one that expanded opportunity for all students, particularly those who have been marginalized and oppressed in science.

In accepting one way of knowing science, the assimilationist science teacher ignores the meaning students assign to experiences at the active and fluid intersection of science and race (Banks, 2016; Ladson-Billings, 2009; Picca & Thompson-Miller, 2016). When teachers communicate, intentionally or unintentionally, that science has no cultural relevance, they become part of a system that oppresses and restricts African American students' opportunity to develop critical perspectives and find relevance in science (Schiro, 2013). Without being able to develop that opportunity, students will fail to develop a healthy intersectional race and science identity (Collins, 2018). Perhaps the assimilationist practices of science teachers continue because many are not aware of the broad expanse of research that includes social reconstructionism, multicultural education, and culturally relevant pedagogy (CRP).

Multicultural education is a concept that addresses classroom tools and systemic change through action and philosophy that emerge from the critical analysis of systems (Banks, 2016). The ideas, concepts, and processes of multicultural education challenge

dominant narratives of the status quo with the premise that not all students have equal opportunities to learn (Banks, 2016). The normalization and permanence of racism throughout American systems suggests that the full effects of multicultural education will never be realized; therefore, the work multicultural education does toward educational equality must never end (Banks, 2016; Bell, 1980). When I consider how multicultural education informs practices that provide students with an evolving variety of opportunities to learn and demonstrate knowledge, my work becomes part of the work toward educational equality (Banks, 2016).

Teachers who reflect value for student experience and diverse demonstrations of knowledge model CRP (Ladson-Billings, 2009). In this study, I explored how understanding African American students' science experiences informed and transformed my practice. Since CRP values student experience and recognizes multiple ways of knowing science, it is a model I thought with throughout my study. As I worked to improve my practice through a deeper understanding of how African American students experience science, my understanding of science grew to recognize a myriad of ways students learn and know science.

Transforming science pedagogy empowers students to persist along paths that lead to emotionally and economically rewarding careers and increases economic parity among races. A systemic critical analysis challenges racialized norms in science and leads to transformative changes that contribute to students' sense of opportunity. The tools to transform teachers' practice into one that challenges norms and expands students' opportunity are embedded in the disciplines of social reconstructionism, multicultural education, and CRP. As a high school physics teacher, I turned to action research to

challenge racial and economic equity through a study of how African American students experience science.

Purpose of the Study

How science restricts African American students' opportunities to enter science careers and achieve economic equality is reflected by the dearth of racial diversity in science (Torraco, 2018). As a precursor to science careers, high school science is aptly positioned for a critical analysis of how it contributes to inequality (Wang, 2013). Research suggests that identifying and removing threats to students' identity, leveraging student experience, and developing students' critical perspectives of education are instrumental in nurturing the intersectional identity of race and science that contributes to achievement (Banks, 2016; Gee, 1989; Ladson-Billings, 2009). The purpose of this critical post-intentional phenomenological action research study was to understand how African American college students experienced high school science and how those experiences could change my practice.

This critical study examined how students' race, when it intersects with science, forms a unique, individual experience and how that experience can transform practice. Black existentialism and identity deepened my understanding of how experience contributes to an intersectional identity and a sense of opportunity. Jointly with student experience, curricular disciplines informed the explicit changes I made to my practice. The transformative changes I made to my practice nurtured students' intersectional race and science identities and lifted the veil that currently divides students' sense of wholeness.

This study's sample was limited to African American college students because they are experts on how African American students experience science (Efron & Ravid, 2013). I restricted the sample to college students because they are more likely to have built a college-competitive high school transcript that includes four years of high school science. Four years of high school science experiences provided more information for this study. Only these participants could provide the specialized knowledge I needed to conduct a reflective critique of and initiate changes to my practice. My analysis of participants' data pushed me to understand the relationship between science classroom experiences and the construction of a robust intersectional identity of race and science in African American students. This understanding allowed me to transform my practice to one that centers students in the classroom.

Research Questions

This study answered the following research questions:

1. How do African American high school students experience science?
2. How can learning about African American students' science experiences inform my practice?

Answering these questions provided insight into the complex relationship among race, science, identity, and pedagogy. More importantly, answering these questions informed the actions I took and will continue to take to expand science opportunities for African American students in science.

Context and Participants

This study preferences the designation of African American to communicate a broad cultural perspective (Ladson-Billings, 2009). Even though African American is the

preferred designation, throughout this study, there are times when context necessitates the use of Black or Black American. The American Psychological Association (2020) explains that unparalleled designations are considered pejorative. Therefore, context determined when the parallel of color was maintained. In descriptions where some students are referred to as White, the designation of Black is used.

My knowledge of this study, in accordance with the purpose of my research, informed my judgment regarding the selection of a purposive sample (Fraenkel et al., 2013). I identified five African American college students from a larger population of college students through self-identified race categories and enrollment in college. As I explained previously, college students were necessary because they are more likely to have pursued a college preparatory path in high school that included four years of science. Those four years of high school science provided a complex wealth of human experience that addressed my research questions. African American students were necessary because they are the only ones who have experienced science as an African American. Of the three female and two male students I invited to participate, only the three females agreed.

As is necessary for action research, a small purposive sample in a specific context allowed me to obtain rich and valuable information that contributed to my understanding of students' experience (Efron & Ravid, 2013). Since my problem of practice centers on the experiences African American students have in science, this purposive sample of three African American college students allowed me to address the purpose of my study. Some action researchers suggest that in qualitative action research, it is more appropriate to focus on individuals via case studies (Efron & Ravid, 2013). However, since my

research centers on understanding the phenomenon of African American students' experiences rather than the individual, a case study would not be appropriate (Efron & Ravid, 2013). In this study, the individual embodies the phenomenon I am studying. Furthermore, my consideration of race is indicative of a critical study in which a purposive sample is necessary to understand the range of experiences within a racialized system (Creswell & Creswell, 2018; Durdella, 2019).

The public school where I work provides the context for this study and is located in Montgomery County, Maryland. The county is a racially and economically diverse suburb of Washington, D.C., but despite the county's diversity, it is segregated. In this school district, African American students are 50% of the student body in some public high schools and 10% in others (Montgomery County Public Schools, 2019a). At my high school, 15% of the student body is African American, and of the students enrolled in honors physics in 2019, only 8% are African American (Montgomery County Public Schools, 2019a). These statistics suggest that many African American students are experiencing science in a way that precludes them from persisting in science. Only one participant attended a public school in Montgomery County (although not my school). Still, my school is a context that is relevant to this study because it is where I taught Andrea, identified my problem of practice, and explored changes to my practice. Next, I will discuss how a critical post-intentional phenomenological action research design allowed me to address my research questions in this context and with these participants.

Research Design

The design of this study embraces the traditions of action research in education by emphasizing human experience and knowledge generation (Herr & Anderson, 2015). The

realm of knowledge interests communicates a vision for the use of new knowledge, which includes technical, practical, and emancipatory interests. Research designs with an emancipatory interest work toward transformation through critical self-reflection (Herr & Anderson, 2015). This study embraces an emancipatory knowledge interest that aligns with a critical paradigm.

The critical paradigm of this study situates my understanding of how African Americans students construct reality in a context where one group is privileged (Merriam & Tisdell, 2016). By embracing a critical post-intentional phenomenological action research design, I engaged in a critical self-reflection that revealed my ethical and moral responsibility to address and challenge injustice and privilege in education (Counts, 1932; Merriam & Tisdell, 2016; Picca & Thompson-Miller, 2016; Vagle, 2018). Action research, in tandem with critical post-intentional phenomenology, formed a methodology for recognizing, addressing, and challenging injustice (Durdella, 2019; Efron & Ravid, 2013; Fraenkel et al., 2015; Merriam & Tisdell, 2016). I will elaborate on the theory and design of this critical post-intentional phenomenological action research design in Chapter Three.

Both the inability of existentialism to recognize race-based restrictions and the shallowness with which phenomenology has explored social justice phenomena challenged and elevated the design of this study (Vagle, 2018). Rather than conceiving of these shortfalls as restrictions to this research design, I have used them, along with critical theory and post-intentionality, to inform the action research component of this study. My understanding of experience as a phenomenon at the intersection of race and

science framed action that addressed students' experiences and sense of opportunity with science.

Phenomenology becomes *post-intentional* when it is put into play with new theories (Vagle, 2018). As phenomenology becomes intertwined with new theory, it moves beyond descriptions of phenomena to understanding how those phenomena evolve with experience. By putting phenomenology into play with other theories, a new intersection forms wherein theory and methodologies for exploring a phenomenon in an evolving, contextual, and historical way are produced (Vagle, 2018).

As I put phenomenology into play with CRT, I was able to explore the phenomenon of how African American students experience science as informed by history as well as the phenomenon's evolutionary possibilities (Vagle, 2018). The action research component of this study allowed me to identify and implement emancipatory interventions that addressed the issues raised by the experiential data (Durdella, 2019; Efron & Ravid, 2013). This methodological combination made it possible for me to visualize the dynamics between race and science so that changes to my practice challenged the inequities perpetuated by science education (Merriam & Tisdell, 2016).

As part of the introduction to my research design, I will introduce data collection and analysis methods here and expand on them in Chapter Three. To address both of my research questions, I used three methods of data collection: the unstructured interview, a post-reflexion journal, and an observation journal. Data from the interview transcripts addressed my first research question and informed the choices I made in addressing my second research question.

I used the critical qualitative researcher's tool, the unstructured interview, to document a counternarrative of how African American college students experience science. While the unstructured interview format permitted freedom to probe and clarify emerging ideas, it retained a general structure (Seidman, 2006; Vagle, 2018). This interview protocol (Appendix A) shows the interview questions that structured the interviews in advance. The protocol consists of pre-planned, structured probing questions that were or were not asked based on the participant's response.

Before I began and continuing throughout the study, I documented, interrogated, and clarified my experiences with science in a post-reflexion journal. This journal raised my awareness of my unique perspectives so that I could address any interference they might cause during data analysis. The term *reflexion* stems from reflexivity, which refers to a researcher's beliefs and perspectives regarding a phenomenon (Vagle, 2018). The term *post* emerges from positivism and structuralism, which assert that human experience must be studied with the scientific method to describe one, correct reality. Post-structuralism resists the idea of a binary understanding of reality wherein one is the true reality and all others are false. In this study, reflexion is posted because I considered my reflexivity as one of many possibilities for the phenomenon (Vagle, 2018). Post-reflexion is a derivative of the phenomenologists' practice of *epoche* or bracketing in which the researcher suspends their beliefs. Instead of attempting to suspend beliefs fully, post-intentional phenomenologists use a post-reflexion journal to illuminate their beliefs and build an awareness of how they might influence data analysis (Vagle, 2018).

A second journal, my observation journal, documented experiences that became data for addressing the second research question. These experiences were limited to my

observations of the practices I implemented. Due to my local school district's restrictions, I only collected data on my activities, responses, and reflections on these shifts in my practice. I was not permitted to include student data, the reasons for which I will elaborate on in Chapter Three.

Each transcript underwent a reduction to code and organize the data into clusters of meaning regarding the phenomenon. As a post-intentional phenomenologist, once I organized the data into clusters, I returned to the data to search for the information that was not coded. Post-intentional phenomenologists believe new ways of thinking about a phenomenon are embedded in uncoded data and are important because they push our understandings into new theories or ways of thinking about theory (Vagle, 2018). My analysis of the interview transcripts allowed me to address the first research question: how do African American students experience science?

As I began to understand how African American students experience science, I explored how my emerging knowledge could inform a change in my practice. This exploration allowed me to address my second research question: how can learning about African American students' science experiences inform my practice? As I implemented actions informed by the interview data, I maintained an observation journal. My analysis of this journal addressed my second research question and allowed me to explore which practices had the most significant influence on the intersectional identity of race and science. As I worked, I had to remain vigilant in my awareness of how my science experiences framed what I was analyzing (Vagle, 2018).

Positionality

As an African American and a former science student, I share a unique, insider status to race, culture, and science with my participants. As the only non-White teacher in my science department, my experiences with marginalization, oppression, and a sense of isolation at the intersection of race and science continue. However, my experiences with oppression and power hierarchies are not restricted to race. Working with my local district's research approval process has also influenced my perceptions of power. When I engaged the approval board, my initial study was denied because I was not allowed to do research at the same site where I worked. Having my initial study denied left me feeling powerless to incorporate my African American students' counternarrative toward challenging and changing a system that did not ensure equal opportunity. As I explored my response to this denial while writing Chapter Three, I realized that this experience reinforced my sense of oppression.

While my perspectives provide valuable insight, they may also contribute to bias, which could skew my data analysis away from student experience and toward my own (Herr & Anderson, 2015). Since phenomenological studies are deemed valid by how well the researcher can separate their bias from the phenomenon (van Manen, 2014), I interrogated my positionality and reflexivity continuously through a post-reflexion journal and again in Chapters Three and Four. While I did not suspend my beliefs, I was aware of their presence and ability to influence data analysis (Vagle, 2018). In Chapter Three, I explored how my newly developed awareness allowed me to focus on making claims supported only from the data I collected (Herr & Anderson, 2015; Vagle, 2018; van Manen, 2014). Throughout Chapter Four, I identified how my positionality could

influence my analysis by addressing how students' perspectives were different from mine. My continuous work on these tasks allowed me to skew my data analysis toward the unique experience of students.

Significance and Limitations of the Study

The findings of this study expand the horizon of understanding how African American students experience science and how their experiences can inform practice. To use experiential data to inform a change in practice, I invited five students to participate in my study. Of the three female and two male students I invited, only the three females agreed to participate. This occurrence eliminated the male African American voice from this study. While the consideration of gender is beyond the scope of this study, having one male participant could have added insight into how gender influences the intersection of race and science. However, having only female participants provided a deeper insight into the experiences of individuals who are marginalized twice, once by gender and again by race, at the intersection of science. Unfortunately, to be certain this occurred I would need a male perspective for comparison.

Another limit to this study was the restrictive nature of my local school district's regulations for research, which eliminated any opportunity to work with current high school students in the school where I work and across the school district. As a result, I was not able to include current high school students' voices as insight into the experiences of African American high school students with science, and this limited the depth of my findings in regard to experience and evaluation of the intervention. In Chapter Three, I will elaborate on this limitation and explain how I redesigned this study to address my problem of practice despite these limitations.

I addressed a final limitation, researcher bias, through my methodology. Whereas action researchers address researcher bias through positionality discussions, phenomenologists believe bias can be addressed and objectivity achieved through the suspension of a researcher's beliefs. This practice is called bracketing, and many qualitative researchers are suspicious of a researcher's claims to be completely objective (Merriam & Tisdell, 2016; Vagle, 2018). To address this suspicion, I adopted the post-intentional phenomenological approach of bridling, which replaces bracketing. Just as a bridle helps to control a horse, bridling my beliefs allowed me to control them. In this study, I addressed researcher bias through the practice of bridling, which allowed me to keep student experience centered during data collection and analysis. Later, I will expand on how the methods I used to bridle my beliefs and a discussion of my positionality addressed researcher bias.

Organization of the Dissertation

As an introduction to my dissertation in practice, Chapter One included an orienting discussion of the problem of practice, related literature, research design, and positionality. An extensive review of literature in Chapter Two uses critical theory to explore how history informed existing understandings of race and restricted science opportunities for African American students. Chapter Two also outlines theoretical models for action that challenge existing science practices. Chapter Three explains the rationale for and design of the innovative methodology I used to address the problem of practice. My findings of students' experience and how their experience informed and transforms practice so that it disrupts oppressive STEM practices are presented in Chapter Four. In Chapter Five I trace the transcendent properties of my findings and

methodology as I explored their broader applications as tools to expand opportunity for African American students.

List of Definitions

Adolescence is the period when an individual physically, emotionally, and intellectually transitions from child to adult. This period usually occurs between the ages of 13 and 18 but may begin sooner or end later.

Assimilationist science classrooms are those in which the teacher recognizes one way of learning science and one way of demonstrating science knowledge while excluding other possibilities of learning and demonstrating knowledge of science.

Black or African American individuals are descendants of Africans who were enslaved and brought to Northern America. For this study, this category of race and culture is expanded to include African immigrants as well.

Black Existentialism narrows existentialism—that individuals are free to determine the course and meaning of their lives—via the consideration of systems of oppression.

Sometimes called Africana Critical Theory or Existentialia Africana, Black existentialism asserts that the freedom described by existentialists is not available to individuals of African descent because racialized social systems work to limit opportunity (Gordon, 2000).

Color-blind classroom practices are those that aspire to eliminate all reference to race and culture. Often, teachers who employ color-blind practices believe they are leveling opportunities by making race irrelevant, but they are devaluing the importance of students' experiences with race and culture (Banks, 2016).

Counternarratives are perspectives that differ from normalized, mainstream perspectives.

Critical Race Theory (CRT) theorizes that racism is normal in U.S. society; race is a social construct. CRT draws on the ideas of intersectionality, counternarrative, and anti-essentialism to explain and document how individual experiences are shaped by race (Ladson-Billings & Tate, 1995; Lynn & Dixson, 2013).

Culturally Relevant Pedagogy (CRP) is a pedagogical model that addresses student achievement by affirming students' identity via the development of critical perspectives (Ladson-Billings, 1995; 2009).

Essence is a term used by traditional phenomenologists to describe the nature of experience.

Essentialism occurs when it is believed that everyone in a group thinks, acts, and believes the same thing (Ladson-Billings, 2013; Lynn & Dixson, 2013).

Existentialist theory asserts that individuals are free to determine the course and meaning of their lives. Existence precedes essence (Sartre, 1956).

Identity is an individual's sense of well-being and unity of personality (Erikson, 1968).

Intersectional identity is framed by how layers of two or more categories, systems, or both mold the meaning individuals assign to experience (Carbado et al., 2013; Cho, 2013; Crenshaw, 1989).

Marginalization occurs when an individual senses that their culture or context is irrelevant to learning or existing in a space.

Multicultural Education is a discipline of education that recognizes the value of diversity across social categories in all aspects of education. The dimensions of

multicultural education move from straightforward classroom practices to broad systemic change (Banks, 2016).

Pedagogy includes a broad range of practices and behaviors that are associated with teaching.

Physics is a branch of physical science that is broadly explained as the study of why things happen. Physics topics include electricity, magnetism, waves, motion, forces, and energy.

STEM is the acronym for science, technology, engineering, and mathematics.

Voice is a term used by critical race theorists to refer to a traditionally marginalized narrative counter to the normalized narrative. Also known as a counternarrative (Lynn & Dixson, 2013).

CHAPTER 2

REVIEW OF LITERATURE

In 2017, CNN produced a vlog series in which African Americans, some more famous than others, described “The First Time I Realized I Was Black” (Jones, 2017). These moments reflected the meaning African Americans make from experiences within a racialized society. Just as the participants did, I, too, remember my moment vividly. These moments might not be sudden, but the awareness that develops is; they are awakenings. Du Bois (1903) explains his moment in this way,

In a wee wooden schoolhouse, something put it into the boys’ and girls’ heads to buy gorgeous visiting-cards—ten cents a package—and exchange. The exchange was merry, till one girl, a tall newcomer, refused my card,—refused it peremptorily, with a glance. Then it dawned upon me with a certain suddenness that I was different from the others; or like, mayhap, in heart and life and longing, but shut out from their world by a vast veil. (p. 4)

The veil divides African Americans’ awareness of how others perceive them from their sense of self (Du Bois, 1903). As individuals of African descent living in America, African Americans manage two irreconcilable consciousnesses: seeing oneself through the eyes of others versus an independent self-consciousness (Alcoff, 2020). This double consciousness has shaped and continues to shape the experiences of African Americans in every context, including education.

This division of consciousness must be considered in curriculum and pedagogy. It is not the deficiency theory, which problematizes African American students and preempts the persistence of African American students in science (Gordon, 2020; Ladson-Billings, 2009). Instead, the experiences of African American students in science classrooms have exacerbated the presumed irreconcilability of African American students' racial identity with science. Through this study, I explored how African American students experience science and how that knowledge informed changes to my practice that disrupt existing patterns of inequity and improve science experiences for African American students.

Research Questions and Overview

As noted in Chapter One, this study answered the following questions:

1. How do African American students experience science?
2. How can learning about African American students' science experiences inform my practice?

Answering these questions provided insight into the relationship between students' experience and my pedagogy, which may expand opportunities for African American students and greater diversity in science. I begin this chapter by explaining how historical contexts have shaped my problem of practice. In critical post-intentional phenomenology, a historical context is essential to understanding how social constructions of race evolved and contribute to the phenomenon of how African American students experience science. I framed the action research component of this study by discussing the historical context first. Following the theoretical discussion that informs this study, I explore how curricular disciplines allowed me to address my problem of practice.

Purpose of Literature Review and Research Strategies

A literature review examines topic related literature to uncover a research problem for further study (Machi & McEvoy, 2016). This chapter is a review of credible literature that explores the identity of African American students as it intersects with STEM. The information gleaned from this review provided historical context, a theoretical foundation, and an argument for exploring my research questions (Machi & McEvoy, 2016). Research from reports, peer-reviewed journals, and books, which include seminal, primary sources, girded the context and theories that inform the study. Research sources included EBSCO, ERIC, Google Scholar, and thrift bookstores (for the purchase of seminal works).

The post-intentional phenomenological and action research method of identifying theories to start thinking with allowed me to explore theories I deemed necessary for understanding the phenomenon while remaining open to other theories (Herr & Anderson, 2015; Vagle, 2018). As I thought about the phenomenon alongside Black existentialism and CRT, I was able to remain open to new ways of understanding how African American students experience science and how students' experiences have evolved with the accumulation of history and a changing context. On both a macro-system level, which I explore in this chapter, and a micro-individual level, which I explore in Chapter Four, theory has enhanced my understanding of how context and history shaped my problem of practice. Curricular disciplines such as social reconstructionism, multicultural education, and CRP helped me connect students' science experiences to emancipatory action-based change that challenges existing ways of learning and knowing science.

Theoretical Framework

In traditional qualitative research, the theoretical framework of a study provides a frame and lens for research. In post-intentional phenomenology, the theoretical framework is the fertile soil from which new lines of thought emerge and grow. These new ways of thinking are named *lines of flight* because of the way they flee from traditional, static ways of thinking about and describing a phenomenon (Vagle, 2018). This generative view of theory, as it was put into play with phenomenological data, pushed the study in new directions (Creswell & Creswell, 2018; Vagle, 2018). In this chapter, I prepared the theoretical soil of this study for the data analysis in Chapter Four.

Figure 2.1 illustrates how the noncurricular disciplines of CRT, history, identity, and Black existentialism combined to inform an understanding of experience that frames the study. Across the top are the noncurricular disciplines that led to my understanding (second row), which informed experience (third row). The understanding I generated from thinking with these theories informed the practices that composed the intervention.

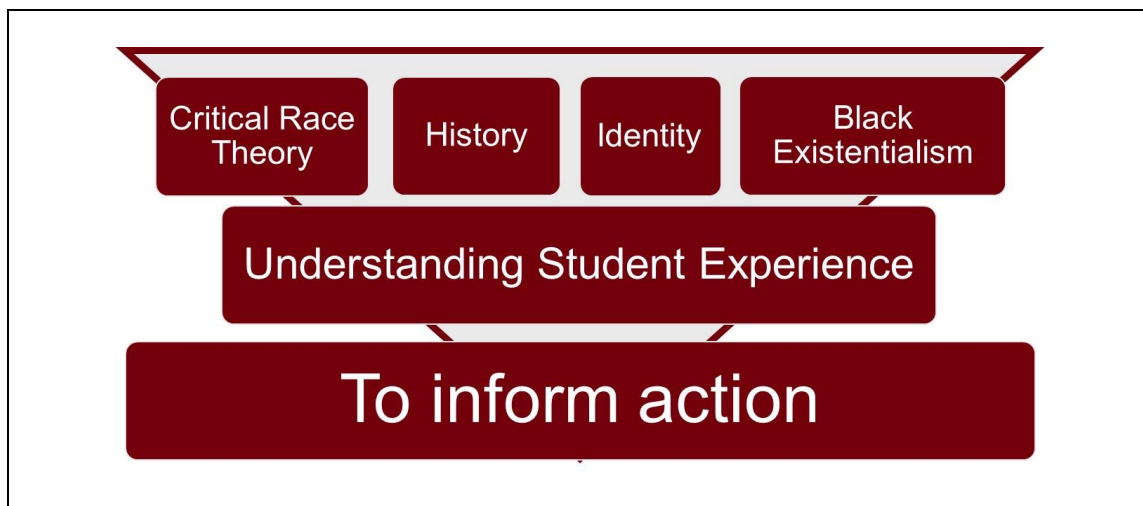


Figure 2.1 Noncurricular Disciplines

The curricular disciplines of social reconstructionism, multicultural education, and CRP provided a theoretical framework for the intervention. Figure 2.2 shows how these disciplines combined to inform the practices I selected for the intervention. At the top are the curricular disciplines that led to the selection of practices for the intervention. The concept of centering the student in practice unified these disciplines.

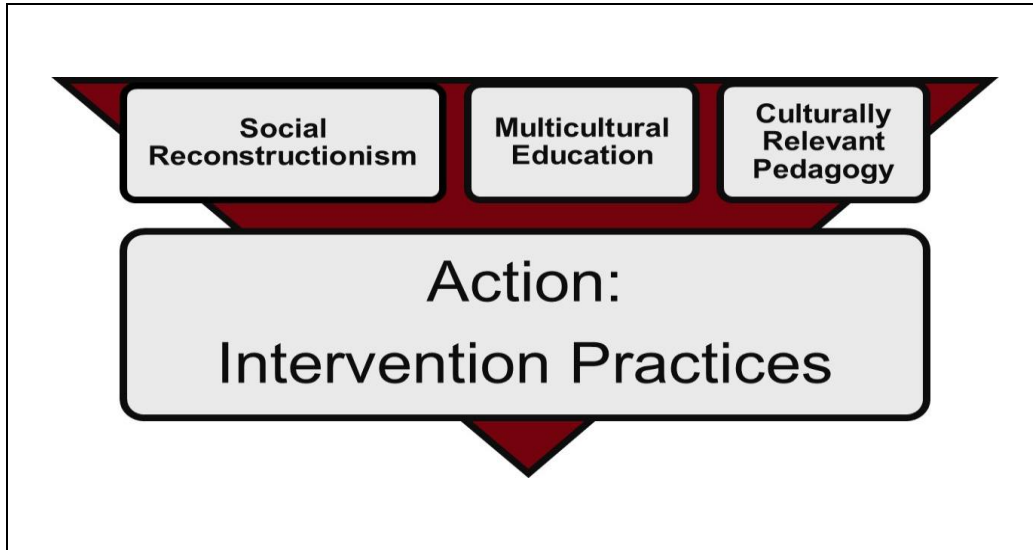


Figure 2.2 Curricular Disciplines

Theory allowed me to clarify and deepen my understanding of my problem of practice and to pinpoint action to transform it. My theoretical understanding begins with CRT because it, along with action research, is the primordial soup from which all parts of this study emerge. Together CRT and action research will allow me to challenge and disrupt existing ways of learning and knowing science.

Critical Race Theory

From the methods I used to study the phenomenon, to the theories I think with, the tendrils of CRT reach into every part of this study. Two hallmarks of CRT employed by this study are: race is a social construct and racism is normal in American society (Bell, 1992; Ladson-Billings, 2013). Critical race theorists assert that inherent in these

racial constructs are messages about power—who has it and who does not (Ladson-Billings, 2013). The social construct of race is not limited to individual understanding but extends to American systems, both of which imbue the experience of living as an American of African descent (Davis, 2016; Ladson-Billings, 2013).

This study also employed the CRT concept of intersectionality, which posits how fields of power, such as law and education, intersect with race to frame experiences and inform identity (Brown & Jackson, 2013; Cho, 2013; Crenshaw, 1989; Ladson-Billings, 2013). Intersectionality added depth to my understanding of African American students' experiences with science as it intersects with race. Rather than essentializing descriptions of experience, intersectionality demands a deep understanding of the unique reality individuals construct at the intersections of social categories. To inform my understanding, I used the CRT researcher's tool, the counternarrative, to explore the realities of African American science students.

The counternarrative centers the voice of students whose narratives have traditionally been marginalized (Brown & Jackson, 2013). Counternarrative construction allows students to name climates that reinforce inequity and instills a sense of empowerment and agency (Alcoff, 2020). The space made by a researcher who illuminates the counternarrative of oppressed voices destabilizes the status quo (Dixon & Rousseau Anderson, 2018; Efron & Ravid, 2013; Ladson-Billings, 2013). In this study, I used the counternarrative to challenge the dominant narrative that color-blind instructional practices in science expand opportunity. Through the counternarrative, the participants were free to articulate a new narrative that included racial oppression and

marginalization as everyday experiences for African American students (Bell, 1992; Brown & Jackson, 2013).

McGee's (2013) case study on biculturalism documented the counternarrative of an African American high school student's experience as the only African American student in his advanced placement calculus class. Biculturalism is an individual's ability to extend their identity to two cultures without losing their original identity (McGee, 2013). McGee's research exemplified how two cultures can inform two discrete narratives. The challenge of existing in both discrete cultures means that one is always forsaken for the other, undermining a sense of wholeness. This case argues against the dominant narrative that academic success ensures a student's persistence in STEM. The participant in McGee's (2013) study felt that math was too different from his original identity. He felt as though being Black and a math major was not possible, and he chose to pursue football, a career he felt was compatible with his racial identity. As I will elaborate later, the counternarrative is not only important to challenging social constructions of race but also to promoting an individual's existential sense of empowerment and agency (Brown & Jackson, 2013; hooks, 1994).

Historical Context: The Evolving Phenomenon

As the historical context of African Americans in the United States continues to evolve, so too does the social construction of race that imbues American systems and individual beliefs. In a bitter loop, American constructions of race inform systems, which in turn reinforce the racialized beliefs of powerful individuals. These beliefs frame systems and our interactions with each other. The possibility that teachers' beliefs are racialized seems more likely when they are informed and reinforced by racialized

historical contexts and systems. Therefore, it is reasonable to conclude that the phenomenon of how African American students experience science and how experience informs identity intertwines with the broader history of American education and racial constructs. Now, I turn to an explanation of how historical contexts of race and education have shaped my existing problem of practice.

To understand how assimilationist, color-blind science education reinforces inequity, critical phenomenologists such as I must understand how historical forces have shaped and racialized education (Bloomberg & Volpe, 2019). In other words, how did we get here from there? As the values Americans have assigned to race have permeated and racialized American systems, education has become restrictive and oppressive in ways that continue to shift, evolve, and change as history is made (Mutegi, 2013; Syed & Fish, 2018; Rosa, 2018).

The significance of living with a non-dominant identity in the United States emerges from African American history and explains the role of context in forming identity. This history reveals how racism has become a normal part of American systems such as education and how those systems shape experiences that inform today's African American adolescent's identity construction. I begin this section with a broad discussion of African American history and narrow it to how history has imbued African American students' experiences with education that shape identity.

The enslavement of African Americans in North America began more than 400 years ago and was legalized in America by the Slave Codes. After slavery was abolished, the Slave Codes were replaced by the Black Codes, which restricted African Americans (Du Bois, 1898). Later, the restrictive Black Codes were replaced by the Jim Crow Laws

that enforced segregation (Mutegi, 2013). For more than 400 years, American codes and laws have sought the same goal, to control and oppress an entire race of Americans, and illustrate the continuous and ongoing oppression of African Americans. This oppression was significant in shaping black Americans' identity and in racializing American systems such as education (Mutegi, 2013).

This study documents the counternarrative of students who have graduated from high schools in suburban Maryland, where the history of African American public-school students has paralleled the history of African American students' education (Montgomery County Historical Society [MCHS], 2019). After the abolition of slavery, and until 1872, when Maryland mandated segregated education, most African American children were educated at home (MCHS, 2019). After schools for Black students opened, the school system's promises of personnel, facilities, and supplies materialized in ways that were subpar to schools attended by White students (MCHS, 2019). Despite these conditions, the pedagogy of many African American teachers included culturally relevant practices (Bell, 2004).

The 1954 *Brown v. Board of Education* ruling mandated the desegregation of American schools and in doing so, seemed to imply that desegregation would ensure the educational needs of all students would be met in one school (Bell, 2004). The ruling was met with significant resistance by the White community, which had historically and successfully used segregation to control, devalue, and oppress the education of Black students (Mutegi, 2013). Despite the court's expectation that school systems would desegregate as quickly as possible (Bell, 2004), it was seven years before the first Maryland schools desegregated (MCHS, 2019; United States Department of Education

[USDE], 2018a). The experience of waiting for desegregation to occur was internalized by African Americans as a signal that the legal oppression of their race had become so normalized that not even the judicial branch could overcome it (Bell, 2004).

When African American students finally enrolled in schools attended by White students, the oppression of African American students' education continued in a new context and form. The court-mandated shift in the educational structure for Black students did not consider the understandings of race as held by many White Americans. Now, African American students attended schools with improved physical condition, but in those schools, culturally relevant teaching did not continue (Bell, 2004; Charleston et al., 2014). Enrolled in schools that had once served only White students, Black students were expected to assimilate into traditional classrooms where non-White perspectives had never been considered. Without culturally relevant experiences, the African American perspective was devalued and erased from the classroom, thus isolating and marginalizing African American students. Black students' experiences in education had shifted and now included an understanding that education was the property of White students (Donner, 2013; Harris, 1993).

In response to this shift, many African American students compartmentalized and separated their racial identity from their academic identity (Du Bois, 1903; Erikson, 1968; Ladson-Billings, 2009; Tatum, 2017). As discussed previously, compartmentalization is a response to an environmental threat (Tatum, 2017), which in this case was racism. Students who did not compartmentalize developed a racial identity that intersected with academic failure (Ladson-Billings, 2009; Tatum, 2017). Systemic and individual understandings of race and the norms that extended from them reinforced

this identity. The notion that education is not synonymous with the African American identity metastasized throughout education and reinforced an essentialized narrative of African American students as deficient (Ladson-Billings, 2009; Mutegi, 2013). This social construction of race reinforced the veil that separates a collective cultural identity from an individual one (Erikson, 1968; Ladson-Billings, 2009; Tatum, 2017).

During the second half of the 20th century, the deficiency narrative informed educational policy that suggested the culture of Black children was deficient to that of White children (Ladson-Billings, 2009). Expressions such as *at risk* placed the locus of the failure to achieve within the African American student. Just as slaveholders had justified slave ownership as due to the deficiency of African Americans, educational policy blamed African American students for their academic failures (Ladson-Billings, 2009; Mutegi, 2013). This perspective failed to acknowledge the historical, intergenerational, and systemic restrictions placed on African American students' identity development.

Today, racial segregation continues in schools and classrooms that lack diversity. In American schools, African American students are 2.4% of the advanced physics course enrollment but 16% of the high school population (USDE, 2018b). In one school in Montgomery County, Maryland, African American students are 15% of the student population and 8% of the physics student population (Montgomery County Public Schools, 2019a). Despite de jure desegregation, implicit messages cause many classrooms to remain segregated. As evidenced by my experience teaching Andrea, when Black students experience color-blind content and pedagogy in classrooms where the majority of students are White, they internalize a profound message that education is

synonymous with a White identity and they are forced to assimilate if they choose to stay (Donner, 2013; Harris, 1993).

The meaning that African American students make from a racialized educational system is influential in forming identity (Tatum, 2017). As African American history has shifted and evolved over the last 400 years, it has shaped patterns in education that have reproduced and reinforced inequity (Bloomberg & Volpe, 2019). A critical examination of education and the meaning students make from their experiences in it is necessary for determining the next steps. As I reflected on my problem of practice, I recognized how historical forces have shaped my learning and, consequently, my practice. Curricular theories justify my argument for centering student voice as the foundation for pedagogy and practice. Before discussing those theories, I explored how identity and existentialism define both a sense of self and opportunity. Understanding this relationship is essential to choosing curricular theories that address an individual's sense of being and becoming.

Being and Becoming: Identity and Existentialism in Education

The phenomenological concepts of *being* and *becoming* are essential to understanding the phenomenon of this study because the participants, African American students, embody the phenomenon in its current state and as it evolves (Vagle, 2018). Recognizing that African American students are not a monolithic, static group of people but instead are individuals who are engaged in a continuous and dynamic process of being and becoming allowed me to seek new ways of understanding how African American students experience science. How African American students experience science is the *being* that informs how experience is embodied, or seen in, the individual. *Becoming* refers to the evolution of the individual or phenomenon with the experience

(Freire, 1994; Soule & Freeman, 2019; Vagle, 2018). In this study, both the phenomenon of experience and the participants were dynamic and fluid as they exhibited the states of being and becoming (Vagle, 2018).

African American students embody the phenomenon of science education experience as they live *through* it. The experiential knowledge I gleaned from interviews was instrumental in bridging my problem of practice with transformative change. However, I had to exercise caution in interpreting the interview data. While all African Americans live within a racialized system, the existential meaning and how it informs the identity of individual African Americans is personal and unique. To assign one person's meaning as representative of all African Americans would remove individuality, homogenize the African American experience, and essentialize the identity of African Americans (hooks, 1994). The idea that meaning is personal and unique explains why Andrea's embodiment of experience as an African American science student did not match mine.

As is the practice of post-intentional phenomenologists, in the following section, I explain and explore the theories I thought with as I worked to understand the relationship between identity and opportunity.

Identity

Identity, individual's sense of who they are, is constructed through the meaning they assign to experiences with race, gender, and class (Erikson, 1968; Carbado et al., 2013). Reciprocally, identity determines how an individual perceives the world around them (Banks, 2014; Erikson, 1968; Tatum, 2017). When identity construction is successful, the final identity produces a strong sense of well-being in adulthood (Erikson,

1968). However, when identity construction is unsuccessful, the resulting identity will undermine the adult's confidence and sense of well-being (Erikson, 1968; Hihara et al., 2019). This suggests identity influences the affective and emotional responses an individual links with experience. It stands to reason that a poorly formed race and academic identity will negatively affect the meaning African American students attach to experiences with science.

During identity construction, if experiences conflict with the student's perceptions of self, they may develop an identity that is undesirable but attainable (Erikson, 1968; Hihara et al., 2019). As illustrated by the veil, these conflicting experiences emerge from the divide between an awareness of how one is perceived versus one's perception of self (Du Bois, 1903). When challenged with conflicting perceptions of an academic self, students prefer to identify as good at being bad at school rather than an academic failure (Erikson, 1968; Tatum, 2017). Just as identity influences meaning, the experiences of African American students with science inform their science identity.

The African American identity is defined in part by its context as a non-dominant culture within a dominant one (Erikson, 1968; Tatum, 2017). The fact that the African American identity has never been dominant is significant to the experience of living as an African American in the United States. It is the pre-abolitionist concept of race in which African Americans were considered inferior that continues to inform a dominant narrative of education (Erikson, 1968; Ladson-Billings, 2013; Mutegi, 2013; Rosa, 2018). As demonstrated by the deficit narrative and underrepresentation in science, the racialization of American systems that began in pre-abolitionist America continues to

restrict opportunity for African American students (Erikson, 1968; Mutegi, 2013; Rosa, 2018; Syed & Fish, 2018).

When the dominant culture actively or passively works to maintain a hierarchy, the identity work of African American students is oppressed. In response, African American students work to reconcile both sides of the veil: the dominant culture's negative perception of them and their perceptions of self (Erikson, 1968; Tatum, 2017). This work oppresses the sense that academic achievement is congruent with race and reinforces African American students' sense of marginalization in education (Ladson-Billings & Tate, 1995; McGee, 2013). When African American students experience marginalization, some detach from academic achievement and some compartmentalize (McGee, 2013; St. Mary et al., 2018; Tatum, 2017).

These contradictory and irreconcilable sides of the veil force African American students into an exhausting cycle in which they must decide, over and over again, which identity to compromise (McGee, 2013). The perceived incongruence of being a strong Black student oppresses Black students' achievement and produces an understanding that education belongs to White students (Dixson & Rousseau Anderson, 2018; Harris, 1993; Ladson-Billings & Tate, 1995; Tatum, 2017). The dynamic cycle of how meaning made from experience informs identity and how identity produces the meaning that individuals make from experience is evidence of how African American students' science identity is both being and becoming.

Black Existentialism

Experiences that contribute to African American students' identity formation are framed by systemic contexts. At the end of her autobiography, *A Colored Woman in a White World*, Mary Church Terrell (1940) wondered,

what I might have become and might have done if I had lived in a country which had not circumscribed and handicapped me on account of my race, but had allowed me to reach any height I was able to attain. (p. 472)

Now, as then, Terrell's (1940) musings reflect the frustrations of many African Americans. Situating this frustration in theory makes theory a tool for overcoming hopelessness and promoting a sense of opportunity (hooks, 1994). Theory allows individuals to comprehend the context of their experience through language and to imagine alternate futures (Herr & Anderson, 2015; hooks, 1994).

While many authors claim the origin of existentialism, I entered this discussion through the work of Sartre (1956), who asserted that individuals define the essence of their existence—the purpose and meaning of their lives—after they come into existence. An existential perspective is the opposite of a religious perspective, which asserts that an individual's essence is known before existence. Existentialism posits the individual's full control of the meaning they make of their life (Sartre, 1956). Education, therefore, serves to make students aware of what exists within them, to awaken it, and to encourage them to develop it (Rumianowska, 2020).

Black existentialists challenged the notion that all individuals have full control of the meaning they make of their existence (Gordon, 2000). While existentialists asserted that individuals are free to follow any path and assign meaning to their experiences along

the way, these principles are not true for African Americans (Rumianowska, 2020; Terrell, 1940; Winston, 2015). Black Existentialism provides a “philosophical grounding to explore the struggle to live within inequity, racialization, and historical oppression as experienced by Black people” (Vereen et al., 2017, p. 73). This theory recognizes the unique experience of living as an African American in a context wherein the struggle for the liberation is predicated on a shared history of slavery and colonialism that has hindered liberation (Bassey, 2007; Gordon, 2000). When systems such as education become racialized, education ceases to be liberatory. Black existentialism, a critical form of existentialism, works to challenge racialized systems.

Black existentialism also explains how experience influences identity. For example, existential deviation occurs when the consciousness beyond the veil, the perceptions held by others, defines the African American identity (Fanon, 1952). In this study, the consciousness beyond the veil is systemic and includes teachers’ practices. This consciousness feeds notions of race and education through a dominant narrative that oppresses the development of an intersectional identity (Vereen et al., 2017). Existential deviation occurs when experiences within racialized systems inform African American students’ identity in a way that restricts opportunity (Fanon, 1952; Gordon, 2000; Vereen et al., 2017).

In my study, the theory of Black existentialism validated African American students’ and Terrell’s counternarrative. Without counternarratives such as Terrell’s (1940), the voices of oppressed people would remain hidden. The counternarratives of African American students challenge the color-blind assumption that race and culture are insignificant in education. These new narratives became tools to deconstruct

marginalizing and oppressive systems (Brown & Jackson, 2013; Weiss et al., 2020). The data I obtained through the counternarrative became a tool for closing the gap between theory and practice (Herr & Anderson, 2015; hooks, 1994).

In this study, I thought with Black Existentialism as I worked to understand how education, when it intersects with race-based experiences, restricts one's ability to define their identity. As I bridged theory with practice, I explored the phenomenon of how African American students experienced science alongside the theories I have explored. In the next section, I will discuss how understanding curricular disciplines allowed me to identify the ways practice can promote equity.

Curricular Disciplines: The Student at the Center of Instructional Design

The following curricular disciplines provide a foundation for my argument for the importance of situating the student at the center of instructional design. When pushed to do so, these disciplines act as theories that can bridge the gap between the need for change and transformative action (hooks, 1994). In consideration of how theory intersects with the historical context of African American students' education, disrupting and transforming existing inequitable educational practices requires action-based change that centers student voice (hooks, 1994; Vagle, 2018). Theories derived from three curricular disciplines justify the actions I took to disrupt and transform my practice.

In its broadest sense, social reconstructionism emphasizes the construction of an equitable society (Schiro, 2013). Multicultural education identifies the root of inequity as the uneven distribution of education, which privileges some students and marginalizes others (Banks, 2016). CRP is a pedagogical model that addresses inequity by protecting academic opportunity (Ladson-Billings, 1995). Together, these theories provide a sound

theoretical foundation for my intervention. In Chapter Three, I will elaborate on the design of the intervention as informed by these disciplines.

Social Reconstructionism

Working toward an equitable education for all students is a teacher's moral and ethical responsibility (Counts, 1932). In his description of social reconstructionism, Counts (1932) asserted that the American ideals of equality and freedom are reflected in education when education benefits all students. Social reconstructionism recognizes the reciprocal relationship of how society shapes experience and how individuals shape society (Schiro, 2013). This concept repeats throughout Black existentialism, which explains how racialized systems restrict African American students' educational opportunities (Vereen et al., 2017). The traditional power hierarchy of the science classroom, where the teacher is the holder of knowledge, shapes experiences that reinforce a restrictive power structure (Joseph et al., 2011). If, as Counts (1932) argues, the goal of education is to build a more equitable society, equity must be practiced in the classroom.

With a vision for equity, social reconstructionism works to flatten power hierarchies and deconstruct restrictive systems. The work to address equity necessitates a critical analysis of most children's entry point to American society, the classroom (Schiro, 2013). The purpose of this study, to understand student experience and use it to inform practice, necessitates an intervention that reexamines the classroom and implements practices that disrupt traditional science power hierarchies. A critical analysis of teachers' beliefs and practices unearths a moral and ethical commitment to this work.

The span of social reconstructionism, from ethical and moral obligations to classroom practices, informs every part of the intervention's theoretical framework.

Multicultural Education

Multicultural education overlaps with the span of social reconstructionism to inform the theoretical framework of the intervention. Like social reconstructionism, multicultural education demands equitable learning opportunities; however, multicultural education addresses specific aspects of education (Banks, 2016). To embrace the tenets of multicultural education is to acknowledge that based on gender, race, sexual orientation, social class, or ethnicity, not all students have an equal opportunity to learn and students who hold certain memberships within these groups are privileged (Banks, 2016; Gay, 2004). When education is deemed the property of White students and incongruent with Black students' identity, privilege and marginalization embody inequity (Harris, 1993; Tatum, 2017). The continued underrepresentation of African Americans in science reflects students' sense of marginalization that limits opportunities in science.

Multicultural education pinpoints action to address inequity across five levels of education. Of those levels, the equity pedagogy dimension is most closely related to this study, and it requires critical analysis at the classroom level (Banks, 2016). When teachers grow their practice to facilitate the achievement of a diverse group of students, they are engaging with the equity pedagogy dimension of multicultural education. My critical analysis of my problem of practice allowed me to understand how my actions reinforced inequity. I had privileged students who did not need to assimilate into my classroom and marginalized those who did. Once I recognized my problem of practice, the equity dimension of multicultural education became a route to dismantling privilege

and marginalization. I followed this route to create an exploratory intervention for how I could grow my practice to include a variety of approaches to facilitate the achievement of African American students in physics.

Culturally Relevant Pedagogy

Ladson-Billings (1995) described CRP as a pedagogical model for addressing student achievement by allowing students to accept and affirm their whole identity. Affirmation of the African American student's identity in the science classroom lifts the veil and nurtures a sense of wholeness. As discussed previously, a sense of wholeness is essential to the construction of a healthy adult identity (Erikson, 1968). Teachers who model CRP promote and nurture the intersectional identity of race and science (Ladson-Billings, 2009). They work continuously to improve their practice to facilitate the academic success of all students (Ladson-Billings, 2009).

The meaning African American students make from experiences within the context of science education necessitated the use of CRP as an instructional model for facilitating students' achievement in science. My goal was to create a change in my practice that affirmed a congruent intersectional race and science identity. Affirming this sense of identity necessitated the use of a model to lift the veil, promoting a holistic affirmation of students' identity. CRP centers instruction on how teacher's beliefs become action and how actions frame experiences and meanings for students that expand opportunity.

Together these three curricular disciplines provide a sound theoretical foundation for an intervention that disrupted and transformed my practice. Next, I will expand on

how the curricular and noncurricular disciplines combine to frame the unique intersectional experiences of African American students in science.

An Intersectional Experience: The African American Student and Science

Intersectionality began with an observation of how African American women were excluded from feminist discourse because of their race and from race-related discourse because of their gender (Crenshaw, 1989; 1991). As each discourse addressed a set of experiences for one social category, they did not address the interaction of multiple experiences (Crenshaw, 1989; 1991). Including African American women in one discourse or the other did not capture how experiences at the intersection of race and gender were more complex than merely combining the two discourses (Crenshaw, 1989; 1991). Intersectionality recognizes how the complex interactions of multiple categories or fields of power influence experience (Carbado et al., 2013; Cho, 2013; Crenshaw, 1989; 1991; Ladson-Billings & Tate, 1995). Now, intersectionality theory is applied to intersections with any number or type of categories, fields, or identities (Cho, 2013; Cho et al., 2013).

For the African American science student, simply adding the category and field of race and science did not reflect the true nature of the student's experience with science. For example, when African American students do well in science, their peers sometimes consider them not really Black, but if they do not do well in science, they are expectantly deficient (Ladson-Billings, 2009; McGee, 2013; Tatum, 2017). This incident is a complex event that could be obscured by a simplified examination of African American students in science. Consideration of African American students in science would not construct a deep understanding of how African American students experience science.

Unique to Black students' experience at the intersection of race and science is the continuous assessment of how others perceive one (the far side of the veil) and the perception that science is the property of White students (Harris, 1993; Horna & Richards, 2018). African American students perceive underrepresentation and irrelevance as messages that their race and science are incongruent, and they are acutely aware of how others perceive them (Ladson-Billings, 2013; Marsh, 2013; McGee, 2013; Tan & Barton, 2018; Tatum, 2017). Unlike their White peers, successful Black science students do additional work to remain engaged in physics while retaining a strong racial identity (Marsh, 2013; McGee, 2013; Tatum, 2017). The work African American students do to resist isolation and marginalization contributes to burnout, and many African American science students leave science (Marsh, 2013; McGee, 2013). Informed by the meaning students make from this unique, contextual, and evolving experience, I can adopt pedagogy that nurtures strong intersectional identities in African American science students and lighten the students' load (Chase et al., 2018; Crenshaw, 1989).

Science identity exists when students see themselves as scientists and is informed by perceptions of self, implicit and explicit messages communicated by peers and adults, and a sense of belonging (Collins, 2018; Stets et al., 2016). A threat to science identity that is specific to the secondary science classroom is assimilationist pedagogy (Picca & Thompson-Miller, 2016). Also described as color-blind pedagogy, assimilationist pedagogy is characterized by policies and behaviors that intentionally communicate that race is irrelevant and that removing it from education broadens opportunity (Picca & Thompson-Miller, 2016). Color-blind practices are highly racialized because they focus on the deliberate and continuous erasure of race (Nieto & Bode, 2016). Erasing race from

the classroom devalues race-based experiences and the meanings attached to them by African American students (Nieto & Bode, 2016; Picca & Thompson-Miller, 2016). What some teachers believe, as I once did, that color-blind pedagogy is benevolent is actually pedagogy that attempts to force students to erase their identity and assimilate (Banks, 2016; Picca & Thompson-Miller, 2016).

It is common for secondary science teachers to dismiss the relevance of culture and student experience to science education (Banks, 2016). Under the guise of irrelevance, science teachers who dismiss culture and experience are practicing a color-blind pedagogy that normalizes one culture in science while marginalizing others (Banks, 2016; Picca & Thompson-Miller, 2016). The fact that Asian and White students are more likely to pursue science careers suggests the assimilationist, color-blind pedagogy of many science teachers is not truly color-blind at all (Banks, 2016; Collins, 2018; National Science Board, 2018). Instead, assimilationist pedagogy oppresses, isolates, and marginalizes African American science students, weakening their science identity.

My understanding of intersectionality allowed me to understand the unique ways African American students experience science as it intersects with race and to name and address problems in my practice that undermine this intersection. Examining students' experiences at the intersection of race and science revealed a perspective that was counter to the dominant perspective of African American students' achievement in education. This new knowledge of the complex intersection of race and science necessitated an intersectional approach to ensure meaning that students assign to experience was not lost (Carbado et al., 2013). Theory, alongside, students' intersectional perspectives informed

an intervention that sought to challenge inequity by expanding opportunity and nurturing identity development in African American students.

Applying the Framework: Addressing Equity in Science Education

African Americans' desire to remove the veil and replace it with one true, whole sense of self is reinforced by the desire to construct a healthy adult identity. Du Bois (1903) expressed it clearly when he wrote,

He would not Africanize America, for America has too much to teach the world and Africa. He would not bleach his Negro soul in a flood of white Americanism, for he knows that Negro blood has a message for the world. He simply wishes to make it possible for a man to be both a Negro and an American...without having the doors of Opportunity closed roughly in his face. (p. 5)

In this study, the doors of opportunity emerge from an individual understanding of reality. Social justice allows me to recognize how inequality among groups emerges from social understandings of difference that shape opportunity (Adams, 2018). Too often, inequality is rationalized through understandings of social differences that have evolved through history. This resulting inequality privileges some groups while devaluing and marginalizing others, essentially closing the doors of opportunity (Adams, 2018).

As I discussed earlier, I did not understand how Andrea experienced my physics classroom. Upon reflection, I believe my practice contributed to her sense of isolation and marginalization, closing doors to her sense of opportunity in science. My acceptance of one reality, color-blind practices, and assimilationist pedagogy prevented Andrea from experiencing physics in a personal and relevant way. As I reflect on my experience, I comprehend the profundity of my moral and ethical responsibility to address this problem

of practice. Research suggests that the racialization of science education can be bridged by a pedagogy that empowers students to develop a strong intersectional identity of race and science achievement (Ladson-Billings, 2009; Tatum, 2017).

At first, it seems that the idea of racism as a normal part of American culture might instill a sense of hopelessness, but Bell (1992) disagrees. The act of challenging oppression engages individuals in a struggle that he asserts is a source of empowerment. Theories generated from new research allow us to recognize a new state of being and becoming that calls us to engage in action toward injustice (hooks, 1994). In her explanation of theory, hooks (1994) asserts that in naming a hurt, individuals can heal and find empowerment. When theory allows us to recognize, name, and address inequality, it becomes a tool for healing and justice.

Related Research

The prevailing body of research on intersectionality could be enhanced by an explicit consideration of the complex intersection of race and science. As intersectionality is still an evolving theory, new applications that extend beyond Crenshaw's (1989) initial application to race and gender are being explored continuously (Carbado et al., 2013; Cho, 2013). Through this study, I improved my practice by constructing an understanding of how experiences at the intersection of race and science influence African American students' perceptions of science. Understanding students' experiences informed changes to my practice that challenge existing norms in science education.

McGee's (2013) work underscores the uniqueness of how African American students experience the intersection of race and STEM. McGee (2013) examined the experience of an African American student who was aware of his two discrete identities.

She found that students who engage with each identity separately sometimes choose not to do so. Instead, they realign themselves with their racial identity rather than with identities, such as math, because math is perceived as White students' property (McGee, 2013). Even though the participant in this study earned a 4.0-grade point average in math throughout high school, he did not continue with math because the cost of assimilation was too high.

Ladson-Billings' (2009) work explored how a group of teachers removed the pressure to assimilate and consequently promoted congruent race and academic identities in students. Her qualitative study employed interviews and collaboration to discover themes in the teachers' beliefs that later became the dimensions of the CRP model. Teachers who model culturally relevant practices design classroom experiences that affirm the intersections of students' race and academic identities (Ladson-Billings, 1995).

Both Ladson-Billings' (2009) and McGee's (2013) research echoes in the work of Collins (2018), Stets et al. (2016), and Young et al. (2017). Their studies underscore how relevant and positive STEM experiences contribute to congruent race and STEM identities. The themes that emerge in the studies by Horna and Richards (2018) and Marsh (2013) reinforce McGee's (2013) work regarding African American students' exceptional effort to manage two discrete identities, one STEM and another race, as the reason why African American students do not persevere in science. This research suggests the existence of practices that reinforce African American students' whole identity. This study explores those experiences and translates them into practice.

Summary

This literature review explored research regarding the phenomenon of how African American students experience science. Reasons for the underrepresentation of African American students in science include problematic pedagogy and systemic oppression. Identity and existentialism are part of the theoretical foundation for understanding how African American students experience science particularly when it restricts opportunity. The curricular disciplines of social reconstructionism, multicultural education, and CRP informed action that challenges how traditional methods of teaching science restrict opportunity.

It is through lines of flight that a critical post-intentional phenomenological action researcher can understand how African American students experience science and explore how that understanding can inform changes in practice. Lines of flight refer to how the phenomenon evolves, shifts, and changes over time and in different contexts. To add to the understanding of how African American students experienced science, I explored how the phenomenon is both a state of being and becoming. An evolving historical context frames and imbues the current educational system that restricts opportunity for African American students in science as well as how it might continue to do so in the future and without intervention. The relationship between science and the students' experience is explored through intersectionality and captured by the counternarrative. In critical phenomenology, intersectionality becomes one way of naming how systems interact with social constructions of race.

The continued underrepresentation of African Americans in science is the rationale for an exploration of African American students' experiences with science. A

critical post-intentional phenomenological action research intervention that is informed by theory and African American students' experiences is the ideal research design for exploring how African American students' experiences can inform changes in my practice that challenge the status quo (Efron & Ravid, 2013). If the United States is committed to the principles of democracy, it must continue its work toward a more equitable society, across all American systems, including education. Students, whose investment in the future of the country is significant because they will be living in it, must have their counter-narratives centered throughout research.

CHAPTER 3

RESEARCH DESIGN AND METHODS

When phenomenology is put into play with critical theory, it “disrupts sedimented patterns of thinking and perceiving, creating conditions of possibility” (Weiss et al., 2020, p. xiv). As I moved away from singular right and wrong solutions to my problem of practice, my work became post-intentional. My critical analysis of historical forces that continue to racialize science education added depth to my understanding of my problem of practice. I realized that in accepting only one way of learning and knowing science, I had embraced an assimilationist pedagogy and reinforced inequity. Naming pedagogy as my problem of practice allowed me to frame the action design of this study. My problem of practice warranted a critical post-intentional phenomenological action research design that was critical, contextual, and employed action toward transformative change (Efron & Ravid, 2013; Vagle, 2018).

The purpose of this study was to understand how African American students experience science and to explore how those experiences can inform action-based transformative change in my practice. The experiences of African American students throughout science courses are relevant to my practice as a high school teacher and my desire to address inequity in science. In my analysis of students’ experiential data, I thought with CRT to understand how perceptions of race influence the meaning African

American students give to contextual experiences with science. Informed by an understanding of how African American students experience science, I implemented changes in my practice that nurture the intersection of science and race identities.

This study was guided by the following research questions.

1. How do African American students experience science?
2. How can learning about African American students' science experiences inform my practice?

In this chapter, I explain how my research paradigm informs the ontology, epistemology, methodology, and methods of this study. I also discuss how the sample and context align with the research design and allow me to answer the research questions. My explanation of the data collection, processing, and analysis methods addresses how I answered my research questions. At the end of this chapter, after I discuss the trustworthiness of the study, I review the limitations, my positionality, and related ethical concerns.

Methodology

The constructs of the critical paradigm, qualitative post-intentional phenomenology, and action research overlap, inform, and guide this study's methodology. In this section, I trace the connections among these constructs to delineate the methodology of this study. Figure 3.1 illustrates the synthesis of the constructs into critical post-intentional phenomenological action research. The four white circles with red font describe each construct that informs the design of critical post-intentional phenomenological action research.

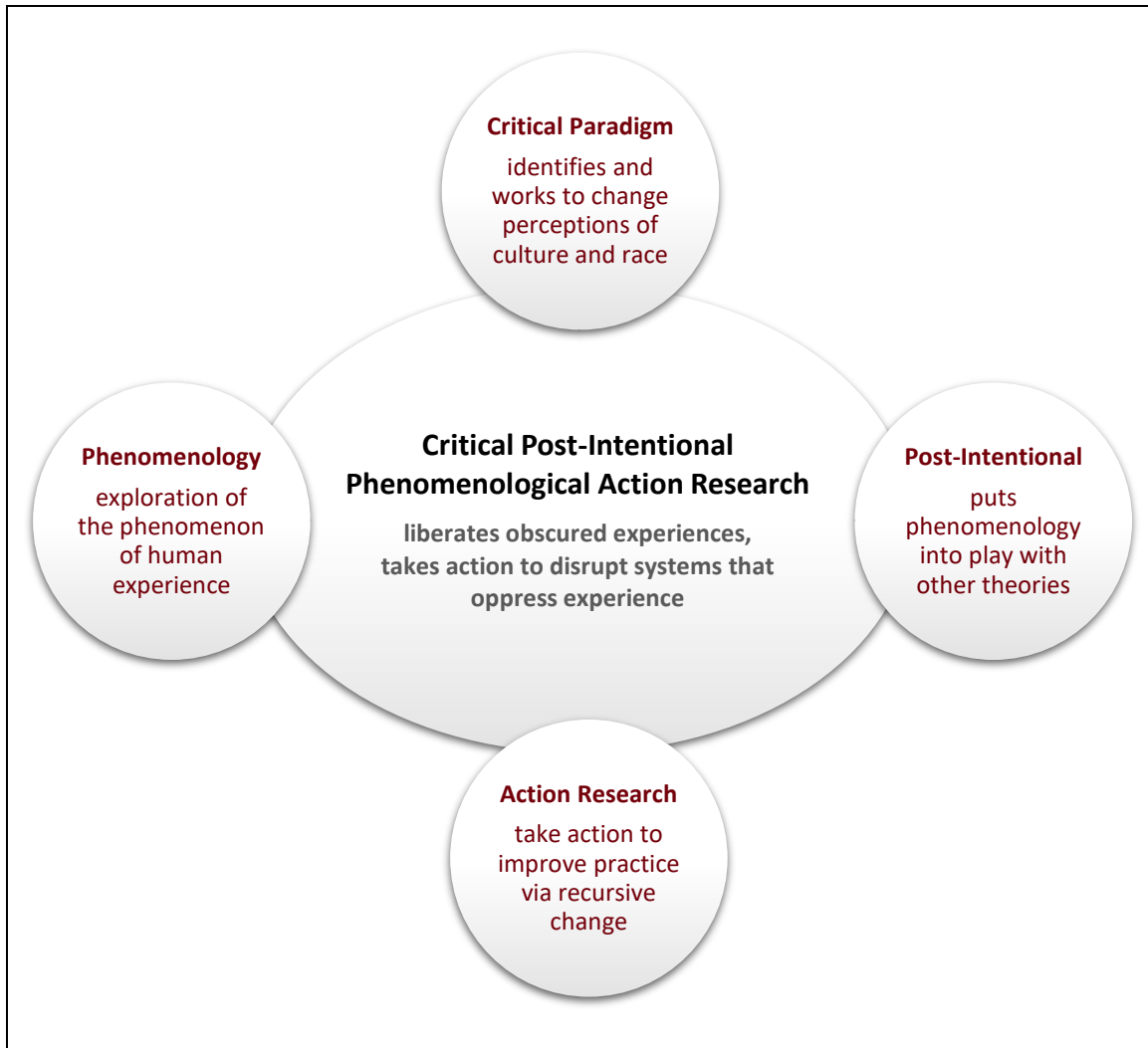


Figure 3.1 Critical Post-Intentional Phenomenological Action Research

The organization of this section is different than the structure of Figure 3.1. To clarify how post-intentional evolved from traditional phenomenology, I combined both constructs into one discussion. My discussion of the individual constructs begins with the critical paradigm, followed by a combined discussion of post-intentional phenomenology, and concludes with action research. The final segment of this methodology section delineates how the four constructs combined to form critical post-intentional phenomenological action research.

Critical Paradigm

The critical paradigm asserts that an individual's reality is constructed via present perspectives of culture and context as they were formed by historical forces (Merriam & Tisdell, 2016; Scotland, 2012). Within the critical paradigm, there are multiple realities in which one is privileged, while others are not (Durdella, 2019; Efron & Ravid, 2013; Merriam & Tisdell, 2016). Like the constructivist-interpretivist paradigm, the ontological position of a critical study is that reality is constructed by individuals. However, the critical paradigm goes further to recognize how an individual's reality is influenced by context and by historical-social power hierarchies (Merriam & Tisdell, 2016). The purpose of a study that recognizes a critical paradigm is not limited to understanding the reality that emerges from the meaning individuals assign to experiences in a system, it also demands action toward confronting the inequities that contribute to those experiences (Merriam & Tisdell, 2016).

The epistemological position of the critical paradigm pushes for change. Narrower in its focus, CRT is a natural extension and application of the critical paradigm to race. CRT emphasizes understanding how racialized power hierarchies form and are maintained, so that they can be changed (Brown & Jackson, 2013). Throughout this study, I used CRT to maintain my focus on the critical paradigm and guide my examination of knowing and understanding reality. Recognizing how the social construct of race and the system of education have worked together to create patterns of marginalization and privilege in science education is significant to my understanding of how African American students make meaning of their experiences in science (Merriam & Tisdell, 2016). However, developing an understanding of students' reality is a

significant challenge to enacting the critical paradigm. The post-intentional phenomenological methodology not only recognizes this but embraces it.

Post-Intentional Phenomenology

Outlining the nature of reality and delineating how researchers come to understand reality informed both the methodology and the methods of this study (Durdella, 2019; Efron & Ravid, 2013). Producing a rich narrative of an experiential phenomenon necessitates the use of a qualitative methodology. In turn, the qualitative methodology demands the use of specific qualitative methods. Capturing the complexity and richness of African American students' experiences with science required qualitative methodology and methods (Merriam & Tisdell, 2016).

In its broadest sense, post-intentional phenomenology is a qualitative research design that produces social change by putting phenomenology into dialogue with other theories (Vagle, 2018). A phenomenon is something explainable, but complex, that is embodied by people as they live through the experience (Vagle, 2018; van Manen, 2003). For example, the phenomenon of this study is how African American students experience science, and as they live through the experience, they embody the phenomenon. Students' race-related experiences in the context of science are complex, but explainable through an exploration of contextual experience (Vagle, 2018).

Phenomenology's roots can be traced to the work of Husserl, whose version of phenomenology emphasized describing the essence of phenomena. Later, phenomenology expanded to include the work of Heidegger, who sought to interpret phenomena (Soule & Freeman, 2019). Both theorists recognized the sharing of phenomena among individuals as intentionality (van Manen, 2003); however, it was

Vagle (2018) who extended phenomenology to include a consideration of how embodiment allows researchers to understand the evolution of phenomena. To the post-intentional phenomenologist, phenomena are ephemeral. They are concurrently in a state of being and in the process of becoming at all times (Soule & Freeman, 2019; Vagle, 2018). This perspective makes it possible for phenomenologists to experiment with phenomenology as it evolves in the context of other theories like CRT (Vagle, 2019).

If phenomena are always evolving and becoming, how is a researcher to understand an individual's reality? It seems phenomenology threatens epistemology. This study addressed this concern by replacing the desire to assess the experiences of African American students with science as good or bad with an understanding of how experience contributes to a unique reality at the intersection of race and science. Broadening epistemology to include the possibility for a myriad of realities informed by diverse sources allowed phenomenology to embrace epistemology (Vagle, 2018). The ephemeral nature of phenomena means that the qualitative data I collected reflects how the individual constructed reality and how their reality continues to evolve.

Vagle's (2018) concept of three *Lines of Flight* reconceives the notion of phenomenology as static descriptions or interpretations to a persistent state of becoming. The first line of flight suggests that phenomena are explained by how they connect and change with experience or context rather than describing what they are (Vagle, 2018). Closely related, the second line of flight explains that the individual, through experience, is not static and changes as the phenomenon evolves. In my study, the first two lines of flight are embodied by African American students who have lived through the experience of science in high school. Their experiences within the context of science education

evolve as they gain experience, and as they gain experience, their identity evolves as well (Vagle, 2018).

The third line of flight considers the individual's evolving awareness of their position with the rest of the world. For African Americans, this line of flight is described eloquently by Du Bois (1903) who wrote, "it is a peculiar sensation, this double-consciousness, this sense of always looking at one's self through the eyes of others, of measuring one's soul by the tape of a world that looks on in amused contempt and pity" (p. 6). Here, he explains his awareness of his position in the world. For African Americans, in contexts where diversity is limited, this experience is intensified. As experiences accumulate, the individual's awareness of their position in relation to the rest of the world evolves.

Perceiving the phenomenon of how African American students experience science as complex, entangled, evolving, and interconnected lines of flight allowed me to uncover multiple, alternative narratives that heretofore have been obscured by dominant narratives. In uncovering these narratives, I was able to understand students' experiences with science and subsequently change them through shifts in my classroom practices. It is the phenomenon's intertwined state of being and becoming that informed the iterative and recursive actions I took to address my problem of practice.

Action Research

Action researchers aspire to improve both their practice and their students' learning (Efron & Ravid, 2013; Herr & Anderson, 2015). The cyclical characteristic of action research refers to the process of new knowledge informing changes in practice, which in turn contribute to new knowledge. This cycle is also recursive in how it refines

new ways of understanding through contextual reapplications of new practices (Efron & Ravid, 2013). In placing phenomenology into dialogue with critical theory and action research, I responded to my findings with action that produced changes in my practice (Efron & Ravid, 2013). Action research is a collaborative model of research that, through work with students, furthered my growth and understanding of how students' experience with science can inform changes to my practice (Herr & Anderson, 2015).

In this action research study, my goals were to understand my students, further my professional development, improve my practice, and address inequity in science (Efron & Ravid, 2013). My emphasis on an emancipatory knowledge interest that was oriented toward the realization of human potential necessitated the use of interviews. Both the interview data I collected and the changes I made confronted inequity in education. By making student voice visible via the counternarrative, I demarginalized the contextual experiences of African American students and took action to expand opportunity for African American students in science. In changing my practice accordingly, I transformed my practice in an intentional, thoughtful, and systematic way.

Action research becomes critical when it works to deepen the understanding of a social phenomenon and transform a system (Efron & Ravid, 2013). The knowledge I generated from African American students' experiences with science contributed to the critical analysis of my practice. The systematic implementation of changes to my practice produced enduring and transformative changes in my pedagogy that continue to challenge the status quo in science education. The action research arena of this study was necessitated by my ethical responsibility to create change that addressed my problem of practice and issues of equity in science.

Critical Post-Intentional Phenomenological Action Research

As illustrated in Figure 3.1, I coalesced multiple methodologies into one unique research design. Vagle (2018) intended for post-intentional phenomenology to be put into dialogue with other theories because, heretofore, phenomenology had not been concerned with the connectedness of human experience and social justice. Phenomenology is *posted* when it moves to the edges of descriptive or interpretive phenomenology, engages with other theories, and explores how a phenomenon has evolved (Vagle, 2018). In this study, post-intentional phenomenology became critical when it was put into play with critical theory to explore African American students' experiences in science. Action research bridged this experiential data with theory to inform action.

Critical post-intentional phenomenology suspends dominant versions of reality, liberates obscured realities, and normalizes experiences that have traditionally been marginalized and oppressed (Guenther, 2020). Action research guides the selection of methods that transformed my practice to one that disrupts historical patterns in science (Guenther, 2020). This innovative methodology framed my study of African American students' experiences with science so that it was relevant to my practice and facilitated its ongoing evolution.

Participants

A purposive sample is chosen when the individuals in the sample possess knowledge that addresses the research questions (Fraenkel et al., 2015). Therefore, to extract the experiences of African American students from the milieu, only African American students were included in the sample. As African American students, they are the expert sources of experiential data that address my research questions (Herr &

Anderson, 2015). Since the knowledge I gained from the data I collected informed changes in my practice, only the data collected regarding students' experiences with science were relevant to this study (Fraenkel et al., 2015; Herr & Anderson, 2015).

Students were selected by self-identified race categories, graduation from high school, and full-time enrollment in a college or university. In Maryland, college students are more likely to have pursued a college preparatory path in high school that includes four years of science. Those four years of high school science provided a complex wealth of human experience with the phenomenon that allowed me to address my research questions. The consent form I used (Appendix B) included a request for parent or guardian permission in case any of the participants were under 18 years of age. However, since none of the participants were underage, I secured informed consent from the participants only. Of the five students who met the requirements for the sample to participate in this study, three agreed to participate. In Chapter Four, just before I share data from their personal narratives, I will introduce each participant.

This sample was drawn from a larger population of African American full-time college students. The students I invited to participate in this study were nominated via community nomination. The community nominators consisted of African American parents of college students who were members of my professional and personal communities. My call to parents to ask for participants resulted in the five nominees. Kogan et al. (2011) assert that personal and professional social networks are an appropriate and efficient method for producing representative sample groups for research.

My sample may be small; however, even with a sample of one or two students, qualitative phenomenological research is possible and, in some cases, preferred (Vagle,

2018). Whereas quantitative research necessitates the use of at least thirty students for statistical analysis, qualitative research demands a smaller sample to permit an in-depth understanding of experience (Efron & Ravid, 2013). With three participants, I was able to engage in an in-depth exploration of their experiences with science.

Context

As I introduced earlier, post-intentional phenomenology is grounded in the evolving conceptions of a phenomenon and as they appear in multiple contexts, they are also shaped by those contexts (Vagle, 2018). This conception of phenomena is reinforced by Black existentialism, which asserts that African Americans' freedom to define the essence of their existence is restricted by systems (Gordon, 2000). In my study, the phenomenon of how African American students experience science is shaped by the science classroom context.

To engage in a cyclical and reflective improvement of my practice, as informed by how African American students experience science, the school where I work had to be the site of my study (Efron & Ravid, 2013; Merriam & Tisdell, 2016). As a physics teacher at the school, I was situated to conduct interventions that address underrepresentation in science. In this study, I leveraged the action research criteria of self-reflective problem solving and improvement of practice to explore how the science experiences of African American students could inform a change to my practice (Herr & Anderson, 2015).

My school is a public high school for grades 9-12 in Montgomery County, Maryland. Montgomery County Public Schools (MCPS) is the largest school system in Maryland, and despite a diverse student population that is 21% Black and 27% White

(MCPS, 2019a), the school system is segregated. *De facto* segregation has produced student populations that are 66% White at one school and 7% White in another (MCPS, 2019a). In response to decades-long shifts in the county's demographics, MCPS has adopted a resolution "to take an in-depth look at promoting diverse student bodies and maximizing facility utilization" (MCPS, 2019b). Outside consultants are researching this resolution; the report will be released in 2020.

At my high school, the student population is 15% Black and 50% White (MCPS, 2019a). Some courses, such as the honors physics course, are even less diverse. This year, 8% of the students enrolled in honors physics are Black, while 87% are White. The percentage of students, by race, enrolled in the honors physics courses does not reflect the county's nor the school's demographics and alludes to a problem of practice. It is also important to note that of 17 science teachers, as a Black American, I am the only non-White teacher. The lack of diversity in science at this school is consistent with the research that African Americans are underrepresented in STEM and necessitates a qualitative research design to explore why.

Research Design

Post-intentional phenomenology demands a flexible data collection process that may be refined as new knowledge is gained (Vagle, 2018). Action research embraces this research design and is essential to ensuring that the intervention appropriately addresses the problem of practice. The flexible design of this study enabled me to explore the phenomenon of how African American students experience science and how experience evolves as it intersects with race and pedagogy in a simultaneous and recursive way. At points during this study, as I analyzed interview data, I was also collecting classroom

data. As I gained new knowledge from interview data, I applied it to the classroom. This messy and entangled process is a recursive hallmark of action research and post-intentional phenomenology. Without this design, I would not have been able to incorporate a continuous and reflective analysis of interview data into new classroom practices.

Before conducting interviews and continuing throughout the entire study, I maintained a post-reflexion journal. This journal was a space where I interrogated how my experiences intersected and framed what I observed. I also noted observations that differed from what I had originally believed to be true. In exposing and interrogating these experiences, I was able to mitigate their influence on my data analysis.

After the participants agreed to participate, I scheduled and conducted phone interviews. Each one-on-one, unstructured interview was audio-recorded, followed a three-part interview protocol, and lasted approximately sixty minutes. After the interview, the recordings were transcribed. The interview protocol (Appendix A) includes contextualization, lived phenomenon, and imaginative questions that allowed me to collect data that address the first research question (Bevan, 2014): how do African American students experience science?

In addition to addressing my first research question, my analysis of the transcripts informed my exploration of the second research question: how can learning about African American students' science experiences inform my practice? Informed by new knowledge, I refined my existing classroom practices of teaching science to reflect the knowledge I gained from the interviews. I documented these shifts and my reactions to them in a second journal, my observation journal. This process is illustrated in Figure 3.2.

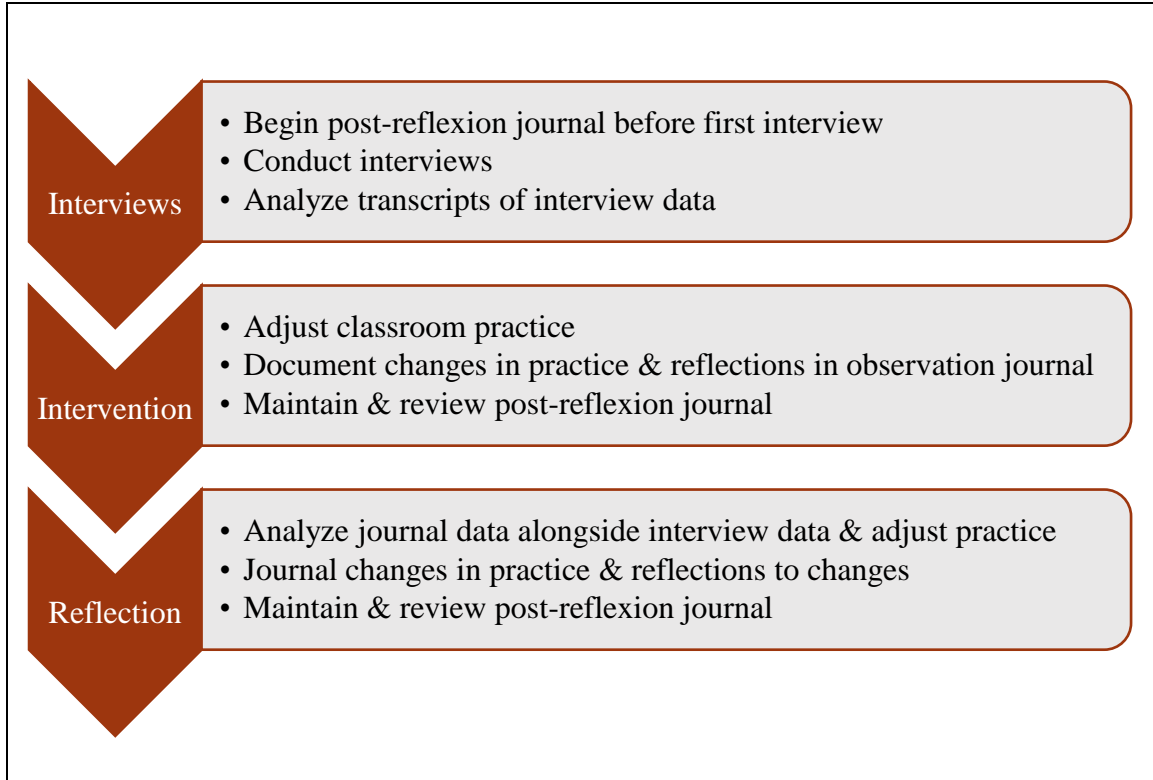


Figure 3.2 Study Sequence

Figure 3.2 illustrates the sequence of steps I followed in this study. Each large, downward arrow on the left identifies a stage of research design. Data collection and analysis occurred throughout the study, but the most significant points of data collection and analysis are placed alongside the interviews and the reflection. The iterative process of action research manifested when I readjusted my classroom practices (Bloomberg & Volpe, 2019). With each cycle of adjustment, I came closer to classroom practices that addressed my problem of practice and inequity in science. Next, I will engage in a deep dive into my data collection and analysis methods.

Data Collection Methods

Interviews and journals were the qualitative data collection methods I used in this study. Data from interviews allowed me to address my first research question and construct an understanding of race as it intersects with science in the classroom context. The changes I implemented reflected the knowledge I gained from an analysis of the interview transcripts. I maintained an observation journal to document my actions and my reflections. Data from this journal addressed my second research question: how can learning about how African American students experience science inform my practice? Throughout the study, I maintained a separate post-reflexion journal in which I explored how my perceptions and beliefs framed what I observed. Since I began this journal before I began the study, I will discuss it first.

The Post-Reflexion Journal

To guard against using participants' experiences to support and justify their own experiences, phenomenological researchers must interrogate their prior knowledge, assumptions, and beliefs about the phenomenon (Vagle, 2018; van Manen, 2003). Traditionally, phenomenological researchers have attempted to suspend their perceptions completely through epoche or bracketing (van Manen, 2003). However, post-intentional phenomenologists believe this task is unreasonable. Post-intentional phenomenologists have chosen instead to locate and describe their perceptions and what makes them, so that they may consciously interrogate how those perceptions frame data collection and analysis (Vagle, 2018). This work is called bridling and is documented in a post-reflexion journal and summarized in a post-reflexion statement.

As an African American science teacher who was once a science student, my knowledge, assumptions, and beliefs undoubtedly framed what I saw in the phenomenon. My experiences have contributed to my sense of identity and would be impossible to suspend. To mitigate the influence of my conception of science on my understanding of the participant's experiences, I used my post-reflexion journal to interrogate my understandings of the phenomenon and to ensure that this study reflected the phenomenon and not my experience (Vagle, 2018).

In my post-reflexion journal, I documented events and thoughts that fell into each of the following four categories: moments of resonance and dissonance, assumptions about what is normal, essential beliefs, and moments I found shocking. These post-reflexion categories help researchers uncover knowledge of which they are unaware (Vagle, 2018). One way of interrogating this knowledge is by writing a post-reflexion statement at the beginning of the study. My post-reflexion statement tied the four categories together with my beliefs and perspectives, and clarified my perspectives of science (Vagle, 2018). I established this journal when I began exploring the conceptual framework of post-intentional phenomenology, and I maintained it until I finished Chapter Five. Throughout the study, I returned to the statement and revised it as needed. As I reviewed my statement, I realized that as I gained new knowledge, my conception of the phenomenon was evolving (Vagle, 2018).

My journal was in an electronic format and stored in an online database protected by two layers of passwords. Each time I made an entry, I began a new page. Figure 3.3 is an entry from January 27, 2020. In each entry, I focused on trying to capture a deeper meaning. With that emphasis and the recognition that ideas came quickly I did not focus

on grammar and spelling. As this is raw data, and a place where I began exploring ideas, I have retained the grammar and spelling mistakes to communicate that authenticity of this entry.

To record:

- Moments of instinctive resonance and dissonance
- Our assumptions of normality
- Bottom lines-beliefs, perceptions, perspectives, opinions we refuse to shed
- Moments we are shocked

Think about:

- My role as researcher
- My assumptions
- My beliefs
- My perspectives
- My background

1/27/2020

Assumption of normality:

As a high school student I thought that feelings of isolation and misfitness were normal. I thought that's how it was. This is why I think I stuck with math and science. It was more of the same.

Belief:

I saw a meme that said "there are 40 million Black people in the United States, that means there are 40 million ways to be Black". While I believe this I have not acted on it. I thought that Andrea's reaction to science had the same reasons as my reaction.

Changing perspective:

My At first it seemed silly to study something I thought was true for all African Americans. However, African Americans are not an essentialized, monolithic group of people who all think and feel the same way. The meaning each of us makes from the intersection of race and science is unique to the individual.

Figure 3.3 Post-Reflexion Journal Entry

At the top of the entry are prompts I put at the top of every entry. These prompts helped me start writing and ensured that my entry remained centered on the phenomenon.

As I wrote, I recorded my raw, initial thoughts. During the entry, I attempted to connect

what I was writing to the prompts. This is reflected in the subheadings I added: assumption of normality, belief, and changing perspective. By maintaining this journal, I did not suspend my beliefs. Instead, I extracted them and put them on display so that I could understand how they might frame my conclusions.

Interviews

Interviews are conversations with a purpose (Merriam & Tisdell, 2016). In this study, the purpose of the interview was to collect information that allowed me to understand how African American students experience science. I used audio-recorded, one-on-one, unstructured interviews to obtain descriptive, structural, and clarifying data from African American students. Since interviews were my primary source of data, this section will engage in an in-depth discussion of this data collection method.

Qualitative interviews are the only way to document participants' nuanced feelings and perspectives associated with an experience (Merriam & Tisdell, 2016). As an outsider to the status of the student-participants, I relied on their commentaries of their experiences with science to capture those nuanced feelings and perspectives. As expert informants, the participants led my understanding of their experience (Fraenkel et al., 2015). Later, my new understanding informed changes to my practice.

Phenomenological interviews are a unique form of qualitative interviewing. In the spirit of post-intentional phenomenology, which interacts with other theories, this phenomenological interview method engages the CRT tool, the counternarrative. In this study, the interview data were comprised of African American students' counternarratives regarding science. Since counternarratives illuminate and elevate voice, they captured the voices of individuals who have not experienced equality (Rudduck,

1993). Using the word *voice* to discuss interview data suggests the release of an oppressed narrative. Students' voice also informed the actions I took to challenge how systemic practices oppress opportunity (Schratz, 1993).

The unstructured nature of the interviews in this study allowed me to move from an observational understanding to a first-person understanding of how African American students experience science (Seidman, 2006). Understanding experience is essential to addressing the phenomenon and my first research question: how do African American students experience science? These interviews are unstructured because I decided which questions to ask during the interview (Bevan, 2014). However, there is a structure embedded in the interviews to ensure the interview does not deviate from learning about the phenomenon and it is detailed by an interview protocol (Vagle, 2018). My protocol (Appendix A) contained questions that kept the unstructured interviews focused on learning about the phenomenon.

As phenomenology centers on exploring a specific phenomenon, some semblance of structure, as designed by the researcher, is necessary to explore the phenomenon thoroughly (Bevan, 2014). The categories and questions I used reflect frameworks suggested by Bevan (2014), van Manen (2014), and Vagle (2018). These frameworks moved the interview from responses that described general experiences to those that reflected individual and contextual experience (Bevan, 2014; van Manen, 2014; Vagle, 2018). Through responsive and active listening during the interview, I selected questions from the protocol that helped students clarify their experiences while keeping the interview within the boundaries of the phenomenon (Bevan, 2014; Vagle, 2018; van Manen, 2014).

The interview questions are divided into three categories: contextualization, how the phenomenon was lived, and imaginative. Questions in the contextualization category allowed the participants to illustrate the context and biography necessary for building a descriptive reconstruction of their experience (Bevan, 2014). If captured correctly, the participants' descriptions should begin to show the significance of the meaning of the experience to the participant (Bevan, 2014; Seidman, 2006). Questions that explore how the phenomenon was lived focus on the structure of the experience and move the participant away from responses that assume the researcher understands to responses that clarify the participants' experience (Bevan, 2014). Imaginative questions clarify the phenomenon by varying the structure of the experience while keeping it in the same context. Imaginative questions may uncover emerging ways of understanding the phenomenon (Bevan, 2014; Vagle, 2018). Since the questions I selected from each of these categories are in response to the participant's answers, an unstructured interview format was necessary.

The three-part interview began with an introduction, during which I introduced myself, reminded participants of the purpose of the study, informed them of the interview structure, and asked them if they had questions (Creswell & Creswell, 2018; Seidman, 2006). Throughout the audio-recorded interview, I took notes to guide my selection of questions that would help me explore emergent ideas from each of the categories. Each interview ended with closing instructions, during which I thanked the participants, reminded them of how I would maintain confidentiality, and offered to follow up by sharing the abstract of my dissertation. I also addressed any questions they had about the interview or the study.

A transcription service transcribed each interview verbatim so I could start reading them as soon as possible. I assessed the transcripts for accuracy and changed student names. A professional transcription service can transcribe interviews quickly, and speed was essential to this study so I could use the knowledge I gained from transcript analysis immediately to inform changes to my practice. I needed sufficient time to analyze the data and conceptualize how new knowledge informed transformative change.

Observation Journal

As is the nature of critical post-intentional phenomenological action research, my observation journal reflected how experience has no true origin and how the cyclical, reflection-based journey of pedagogical self-improvement never ends. To build a holistic, reflective image of the changes in my classroom practices, I needed to incorporate the counternarratives of my African American students. Unfortunately, the restrictive nature of my school district's research policies precluded me from using any data obtained from students at the school where I work. Later in this chapter, I will detail further how these limitations have impacted my study. I address it here to explain why I have not, as I should have, included the voice of the African American students I teach.

A hallmark of action research is the iterative relationship between reflection and action that pushes the practitioner to construct knowledge that produces transformative change in their practice (Efron & Ravid, 2013; Schratz, 1993). Journals provide descriptive and reflective observations that can inform practice (Durdella, 2019; Merriam & Tisdell, 2016). As I analyzed interview data, I returned to the disciplines I discussed in Chapter Two. As I reflected on the data and theory, I considered how they could inform the specific actions I took in my classroom. I used my observation journal to document

my actions and any insight, observations, and thinking I used to transform my initial interpretations into pedagogy. In the journal I also captured my reactions to the changes and summarized everything in a narrative statement (Durdella, 2019; Merriam & Tisdell, 2016; van Manen, 2014). I have shared a journal excerpt in Figure 3.4.

Activity Date: 3/9/2020	Reflection
<p>Today I</p> <ul style="list-style-type: none"> • asked students to share what they already knew about Earth science on a white board in the format of a word splash. • I used this information to introduce new ideas. Each time I put a new word up I asked students to share what it sounded like or reminded them of • Examples <ul style="list-style-type: none"> ○ Propagation-many had read Animal Farm in 8th grade and were familiar with the term propaganda. • Students constructed definitions for words and we synthesized them to build understanding 	<ul style="list-style-type: none"> • At first students were hesitant to share what the word reminded them of I heard someone say the thought their idea was stupid...had to make sure students knew that I valued their ideas Students were engaged in discussion with each other and with me • They did not get off task/They debated and shared connections they had seen with the words from other places/More students than usual were excited to share/This was positive, and I was amazed at how this otherwise boring activity came alive. • I was amazed. Instead of not talking, the student was fully engaged in class today and was in his group's discussions.
<p>Narrative: Today's change in practice emphasized structured student discourse with room for students to add in personal knowledge. Clearly I haven't done this in the past because some kids thought their ideas were stupid. I recall that I circled back and instead of saying "your ideas aren't stupid" I asked the kid more questions about what it reminded them of and listened-trying to show that actions speak louder than words. It was interesting to hear students use the words from the prior round to explain words in the new round-I could see that the definitions they constructed made much more sense. I have this developing awareness of how when I teach these as notes, I am communicating an assumption that students know nothing and that I need to bank information in their brains. Instead I think this lesson did more to extract knowledge from students—just like the CRP model asserts is important.</p>	

Figure 3.4 Abbreviated Observation Journal Entry

Since the journal was electronic, I copied and pasted an entry into the figure. In Figure 3.4, I described my activity in the top left column and my initial reflections in the top right column. In the narrative row on the bottom, I summarized my reflections. In the summary, I worked to clarify how my reflections connected to my theoretical framework. Even though I shortened the entry to fit the space, it is still a good representation of the entries I made in my observation journal. However, to ensure that I share my data with integrity, I have included the original entry in Appendix C. In both Figure 3.4 and Appendix C, I have preserved the spelling and grammar mistakes to reflect the rawness and authenticity of the data.

As I wrote, I paid close attention to ensure I had data in every box but I found it difficult to keep the reflective and narrative sections of my journal separate. Since the practices I implemented were informed by the findings of my interview data, the activities I selected are detailed in Chapter Four.

Data Analysis

In action research, the goal of data analysis is to produce an understanding that informs a change in practice (Bloomberg & Volpe, 2019; Herr & Anderson, 2015). Qualitative data analysis methods were necessary in this study because they are sensitive to the underlying meanings that constructed my understanding of the phenomenon and informed changes to my practice (Merriam & Tisdell, 2016; Seidman, 2006). Data analysis that is not done critically runs the risk of reinforcing the very status quo it sets out to challenge (Herr & Anderson, 2015). To critically analyze the intersection of race and science, I engaged the theories I discussed in Chapter Two and my post-reflexion journal to help me think through my qualitative data analysis. My approach was holistic

and richly descriptive, illuminating a complex and unseen science-reality for African American students (Fraenkel et al., 2015).

Critical race theory, specifically the concept of intersectionality, informed how I thought about the evidence I analyzed with regard to how science intersects with race. Ladson-Billings and Tate (1995), in their discussion of CRT in education, argue that the intersection of race and property becomes an analytic tool when it is used to understand inequity in education. Therefore, understanding students' experiences at the intersection of race and science allowed me to understand underrepresentation and racial inequity in science. An ongoing part of my data analysis was to return to my post-reflexion journal to consider how my experience affected the ways I perceive the phenomenon. This part of the analysis was messy, iterative, and entangled (Vagle, 2018).

I used phenomenological reduction to identify interview transcript data that reflected the embodiment of the phenomenon (Durdella, 2019). Within this practice, researchers use horizontalization, in which all data are examined and given equal weight, regardless of repetition. Since all pieces of data are considered equal, horizontalization produces a broad and rich description of the phenomenon (Vagle, 2018). The first time the researcher reads the data, they mark all areas of interest or perceived connections in the same way. I used yellow highlighter to mark these areas in the transcripts. These areas of interest do not contain beliefs or opinions (van Manen, 2014). During reduction, the researcher should not consider why they are identifying these passages (Seidman, 2006). After marking the initial passages, the researcher returns to the material to examine the identified areas of interest and consolidate them into clusters of meaning. Subsequent readings engage the post-intentional strategy that examines passages not

previously identified. Figure 3.5 is an excerpt from the analyzed transcript of my interview with Claudia (pseudonym).

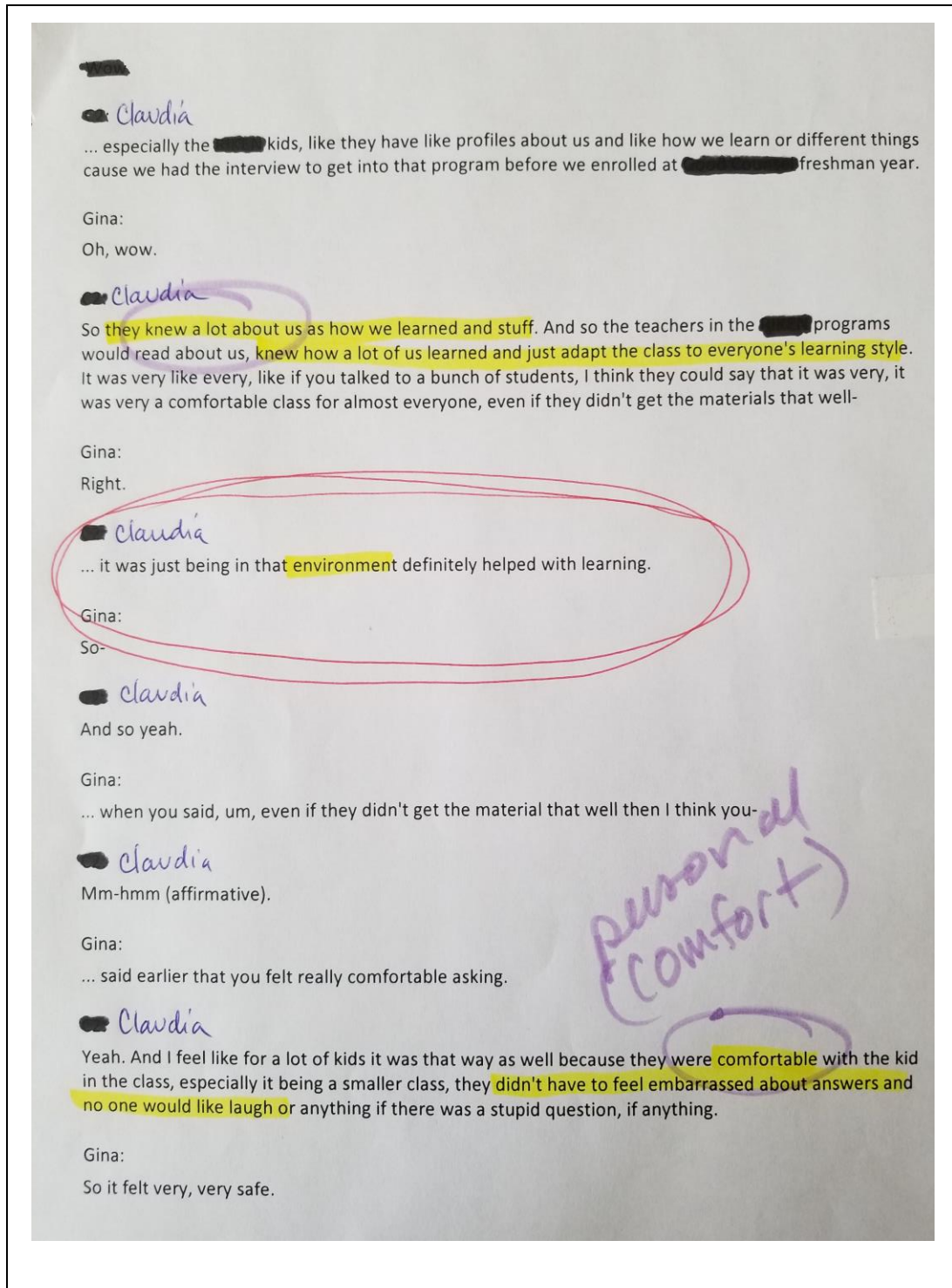


Figure 3.5 Excerpt from Reduction of Claudia's Interview Transcript

In my first reading, I highlighted in yellow the comments I perceived were meaningful embodiments of the phenomenon. During the second reading, I used purple ink to signify preliminary clusters of how the phenomenon is embodied. The example here was later consolidated into the *positive experiences* category. Subsequent readings were noted by red ink and identified passages not previously identified or identified them in a new way. In this example, red ink recognized the full passage and not just the word *environment*.

The red ink in Figure 3.5 illustrates how post-intentional phenomenology expanded phenomenology via reduction. After data that embodied the phenomenon was identified and organized, I returned to the data to examine what was left behind. It is here, in this *left behind data*, that phenomenological researchers discover ways of thinking about the phenomenon (Vagle, 2018). These new ways of thinking pushed my understanding of the phenomena away from the center of traditional conceptions of the phenomenon and into new, generative directions (Vagle, 2018). After the left behind data was identified, I returned to theory to see if and how the data extended these new ways of thinking (Vagle, 2018). In Figure 3.5, I used red ink to show how I expanded my original yellow-highlighted line from *environment* to include *learning*. In returning to the transcript and identifying previously unrecognized data, I was able to consider the *relationship* between learning and the environment. It was the relationship that I connect to a discussion of theory in Chapter Four.

My post-intentional data analysis led to two lines of flight that, in addition to curricular disciplines, informed the design of the intervention. In Chapter Four, I elaborate on the lines of flight, my specific actions, and my reflections of them. During

and after the intervention, I performed a second reduction analysis on the entries from my observation journal. This second reduction allowed me to identify which of my actions seemed to have the greatest influence and I was able to support my initial suppositions of how student experience can inform practice.

Throughout this process and particularly when I discovered data or interpretations that disagreed with what I thought was true, I returned to my post-reflexion journal. As I reviewed my journal, I reinforce my understanding of the possibility for multiple ways of experiencing science, which kept my work centered on the many ways African American students experience science.

Trustworthiness

In qualitative studies, reliability refers to how well the research findings can be replicated, validity communicates how well analysis aligns with reality, and transferability examines how well the findings of a study can be applied to other contexts (Merriam & Tisdell, 2016). The existential nature of phenomenology asserts that reality and meaning individuals make of the world are unique to each person and cannot be replicated, thus making many common qualitative measures of reliability inapplicable (van Manen, 2014). The highly unique, personal, and existential nature of phenomenological data challenges qualitative validity methods as well (van Manen, 2014). In this section, I discuss how I addressed the trustworthiness of this phenomenological study.

Post-intentional phenomenological studies focus on looking in between sets of data. These in-between places are regions where existing notions of phenomena burst into new ways of being (Vagle, 2018). Therefore, using a validity method that looks for the

repetition of data across contexts or in alignment with other data sources to confirm interpretations would force the researcher to disregard these new ways of being. In post-intentional phenomenological data analysis, all parts of the data are given equal weight, not just the ones that appear to repeat (van Manen, 2014). Instead of looking for parallels in multiple sets of data, post-intentional phenomenologists look for original insight via a sound interpretive process (van Manen, 2014).

The reliability of this study is addressed through the sound interpretive process detailed in this chapter. This discussion of methodology and design presents a justification and foundation for the actions taken to address each research question with data (Bloomberg & Volpe, 2015). While the participants of a new study would produce different data, this discussion would allow researchers who wish to understand experience and use experience to inform practice to replicate this study. The discussion of my findings in Chapter Four further enhanced the reliability of this study as I provided evidence solidifying how the data collected using these methods answers the research questions (Bloomberg & Volpe, 2015).

Phenomenological studies can be validated, but not in the way most qualitative studies are validated. In this study, I employed van Manen's (2014) four validation criteria for phenomenological studies. First, the research questions of a phenomenological study must question experience. My first research question, how do African American students experience science, is about experience. Second, data analysis must be based on participants' descriptions and not their opinions or beliefs. My analysis of interview transcript data used colored ink to identify participants' experiential descriptions. These

two criteria refer to the research questions and the data analysis. The next two criteria address the use of literature and methodology.

The third criterion states the study must use scholarly and primary phenomenological literature. In this study, I included research by van Manen (2014) and Vagle (2018). The works of van Manen (2003; 2014) are widely accepted as foundational to how phenomenology serves professional practices such as education, while Vagle (2018) is the first to articulate post-intentional phenomenology. I also referenced Weiss et al.'s (2020) recent text, *50 Concepts for a Critical Phenomenology*, an extensive scholarly text on critical phenomenology that serves as a resource for critical phenomenologists. Fourth, the study must avoid the use of non-phenomenological validity methods. Since traditional qualitative methods of validity, such as the triangulation of perspectives, contradicted the design of this study, I did not use it. Instead, I implemented van Manen's (2014) four phenomenological validation criteria to underscore the trustworthiness of this phenomenological study.

The transferability of this study exists in two dimensions. First, regardless of the inimitable qualities of the data, transferability of the findings to other contexts is possible. My use of purposeful sampling and the construction of a thick, rich narrative ease the reader's ability to connect the findings of this study to new contexts (Bloomberg & Volpe, 2015; Merriam & Tisdell, 2016). Second, transferability includes the methodology and design of this study. The design of this study expanded the sphere of action research to include both critical and post-intentional phenomenology. The detailed methodological descriptions I wrote facilitate the design's transferability to new contexts where

researchers wish to combine critical analysis with experience to inform action (Merriam & Tisdell, 2016).

Early phenomenological researchers worked to suspend their beliefs and eliminate bias. More recently, researchers have acknowledged how unrealistic it is to believe that all beliefs can be suspended entirely. Even van Manen (2014) explains how “all understanding presumes preunderstandings” (p. 354), which supports the perspective that our ways of thinking are based on our unarticulated understandings of the world around us. Since we are not aware of these understandings, it is impossible to suspend them and bias is unavoidable. In action research and post-intentional phenomenology, bias is addressed through positionality and post-reflexivity statements. In these statements, researchers explore and interrogate the role of their background, beliefs, values, and attitudes in a study (Bloomberg & Volpe, 2019; Herr & Anderson, 2015). An action researcher's role within a study necessitates a discussion of positionality to address sources of bias (Herr & Anderson, 2015). Post-intentional phenomenology underscores this because it requires a discussion of reflexivity to bring clarity to how a researcher’s beliefs frame what they see (Vagle, 2018). Once positionality and reflexivity are addressed, the researcher may find it easier to center participants’ experiences with the phenomenon (Vagle, 2018). Throughout this study, I interrogated my positionality and reflexivity continuously to maintain a focus on students’ experience.

Since I began my post-reflexion journal when I started researching post-intentional phenomenology, it is extensive and allowed me to interrogate my positionality throughout the study. Vagle (2018) suggests starting the journal as soon as you begin thinking about the phenomenon and continuing it even after the study is done. Near the

beginning of my journal is a post-reflexion statement that describes my role as a researcher, as well as my background, assumptions, beliefs, and perspectives as they relate to the phenomenon. Organizing these in a statement made it easier to name and separate my bias from the data (Vagle, 2018). Whenever I engaged in data analysis, I revisited my post-reflexion statement, revised it if necessary, and used it to interrogate what frames my perceptions.

To explain how my reality frames what I see, it was essential for me to illuminate the many ways in which my identity intersected with this study. In my positionality discussion, I included a description of my identity and my initial post-reflexion statement. My discussion of positionality also acknowledged how the limitations of this study have framed my perspective. Since the limitations had a significant role in my positionality and my reflexivity, I will address the limitations of this study first.

Limitations

Section IV.A.3.d of the Regulation on Research and Other Data Collection Activities in Montgomery County Public Schools (MCPS) (2016) states that research activities conducted in the school or office where the MCPS staff member is employed, unless approved by the chief of staff, the chief academic officer, the deputy superintendent of school support and improvement, and the chief operating officer will not be approved. (p. 4)

Since I am an employee of this school system, any research I did was limited by this regulation. Originally, I intended to use a critical ethnographic methodology to explore an explicit pairing of my school system's culturally relevant physics curriculum with their research-based document on equitable practices. One component of approval for research

is the benefit of a study to the school system (MCPS, 2016). I believed my original study would have been deemed valuable to the school system and that it would have been eligible for review by the chief of staff, the chief academic officer, the deputy superintendent of school support and improvement, and the chief operating officer. When I realized approval involved many offices, I submitted my application as early as I could.

MCPS denied my proposal without review, explaining that because the study was to take place in the school where I worked, they would not consider it for approval, nor would they move it through the different offices for consideration. Through emails, phone calls, and personal visits to individuals with the research approval office, I explored every possibility I could for obtaining approval from my school district. I tried to shift the study to collect data from other high school students, but MCPS's limitations on research, which included that other teachers were not allowed to give out invitations on my behalf, were too challenging to overcome. After exploring every possibility, I accepted that my original study had been denied and, with the support of my dissertation chair, began exploring alternative research methodologies.

I searched for a methodology that would allow me to retain African American students and science as central to my study without using current MCPS students, thus making MCPS's approval unnecessary. I chose a critical post-intentional phenomenological action methodology because it allowed me to explore and critique new ways of thinking about the phenomenon of African American college students' experience with high school science. Since my participants were college students, I did not need approval from MCPS. The action research segment of this study involved how my knowledge of college students' high school experiences could be used to inform my

practice. Since I intended to document only my responses to changes in my practice, thus collecting no data from current MCPS students, MCPS informed me that they did not need to review this study.

Even though I invited and encouraged three female and two male African American college students to participate in this study, only three females agreed to participate. Therefore, the lack of a male perspective could be considered a limitation. Without a male perspective, it is impossible to be sure if my findings of how African American students experience science were influenced by gender or if they are broad enough to remain centered on race. In an attempt to address this limitation, I made sure I worked with male and female African American students in my classroom; however, without being able to collect student data, I was not able to address this limitation confidently.

The recent nation-wide critical self-analysis of our social constructs of race that was precipitated by the murder of George Floyd necessitates a closer examination of how gender intersects with race and academic identity. This includes how African American men perceive the world differently than African American women. As a female African American advanced placement (AP) physics teacher, I have experienced this difference via dismissiveness and outright resistance from several male students. In those experiences, I was never sure if my race, gender, or both influenced their beliefs about who knows physics. Traditionally in science, African American females are marginalized twice by race and gender, whereas African American males are marginalized once by race (Morton & Parsons, 2018). Exploring the validity of this could bring a deeper

understanding of how teachers' preconscious understandings of the intersection of race and gender may lead to experiences that restrict or expand academic opportunity.

In a new study, where I would examine how race and gender intersect with academic identities, I would work to obtain rich, unencumbered data on gender by hiring a male to interview male participants. Just as I suspect female participants' ease in speaking with me may have emerged from our shared gender, I feel that the best way to collect the same rich data from male students would be through a male interviewer. The findings of such a study could help teachers expand and translate their preconscious understandings of race and gender into classroom experiences that reinforce a sense of academic and economic opportunity for male and female African American students.

In the following discussion of positionality, I continue to explore my study's limitations and how they and my identity frame what I see. The work of crafting this section ensured that throughout the study, participants' experiences and not my own were centered; my positionality was a point of reference for my post-reflexion self-interrogation. As you will see, my district's limitations for research have contributed significantly to my assumptions, beliefs, and perceptions. Without exploration, my beliefs and perceptions would have easily obscured the phenomenon of African American students' experiences with science.

Positionality

Thirty-five years later, I recall the following incident vividly. I can see the teacher's sneer as he looked at me and said, "I bet you can't tell me the difference between a speedometer and an odometer." I remember the sense of panic and all of my thoughts. Why is he sneering at me? Why is he asking me this question? Why is he

noticing me at all? As I answered his question correctly, his sneer was replaced with a look of surprise. My mind raced. Why is he surprised? Why was I the only student asked this question? Is it because I'm Black? A girl? I remember thinking, "you have no idea what I know. Ignore me. Just stand up there and teach. Don't notice me at all."

This incident occurred when I was in tenth grade, as a Black student at a predominantly White high school. The memory of this experience has resonated with me deeply and broadly, to my core, and across decades as a perception of the world that I cannot give up. I believe it has stayed with me because it has repeated in different variations and contexts throughout my life. I share it here, because it vividly captures my experiences as they frame my perspective of science. Throughout school and sometimes with family, my sense of isolation resurfaced, and I assumed it was a normal way of being.

In the 1970s, as the child of a Black father and a White mother, I was treated differently by extended family. The sense of isolation I felt in school was no different than the parts of my life with extended family, and I accepted it as normal. The isolation I experienced throughout high school, college, and now at work, where I am not just the only Black teacher but also the only non-White member of my science department, has become a normalized part of my academic and professional career. In understanding my perspective and how it frames what I see, I recognize my desire to see it paralleled in data. By recognizing this in myself, I am better prepared to look beyond my experience and into the experiences of my students for new meanings of experience.

As an African American woman working with young African American women, I am an insider working with other insiders to race and gender (Efron & Ravid, 2015). As

an African American woman, I believe I was afforded a certain level of trust by my young African American female participants, which allowed me to collect interview data more easily. However, my insider status also challenged me to identify, document, and properly communicate the participants' experiences to ensure they were not my own (Herr & Anderson, 2015). I addressed this challenge by maintaining a post-reflexion journal in which I interrogated my experiences separately from those of my participants. My insider status also provided tacit knowledge of my participants, or perhaps the perception of tacit knowledge. For example, through my post-reflexion journal, I realize I projected my experience with racial isolation as a norm onto Andrea and, in doing so, failed to explore the possibility that my problem of practice was centered in my practice and not in the students.

The focus of critical research, in theory and methodology, is on how power hierarchies oppress some individuals while privileging others (Bloomberg & Volpe, 2018; Merriam & Tisdell, 2016). The unique role of action researchers in a study also contributes to power differentials that may bias research (Herr & Anderson, 2015). Since this is a critical action research study, and I have addressed power in my discussion of theory, I must also discuss it as it applies to my methodology, and specifically through my experience with research limitations. Furthermore, to guard against usurping participants' experiences, I used a post-reflexion journal to bridle my experiences and examine them (Vagle, 2018). This journal is described in detail in the data collection methods section of this chapter.

Another issue of power surrounds my perception of this study's limitations. As I discussed earlier, my local district's regulations for research limited my original study to

such an extent it was no longer executable, resulting in the development of a new study. As I reflected on that experience, I began exploring how it was pertinent to my positionality and my reflexivity through my post-reflexion journal. This excerpt from my post-reflexion journal illustrates how I began to connect my emotional response to my new study:

I wonder if I have chosen Black Existentialism (how oppressive systems restrict the meaning people of African descent can make of life) because I felt restricted by my school system to choose how I wanted to challenge the ways that science education restricts my African American students' opportunity. I feel angry sometimes, and I don't think I have moved on from that incident. This thought came to me suddenly and instinctively resonated with me.

In the same entry, a few empty lines later and heavy with emotion that returns to me when I reread it, I wrote, "No more water, fire next time." As I dug deeper into why I wrote this, I comprehend that my biblical and literary understandings of this comment were preconscious. Phenomenology works to understand the meaning of experience through language (Vagle, 2018; van Manen, 2014). In this section, I will use language to explore the preconscious meaning I gave to that quote.

The expression, *No more water, fire next time* is often connected with James Baldwin's (1963) book, *The Fire Next Time*, which borrowed its title from the African American spiritual, *Oh Mary Don't You Weep*. The song warns, "God gave Moses the rainbow sign, no more water, but fire next time." Through church, I was taught that this was a warning for oppressors of opportunity. As a spiritual song of resistance, originally sung by slaves of African descent, it was a warning to slave owners. Baldwin (1963) used

it as a warning to society if it fails to work to raise the racial consciousness of everyone. For me, the quote was the beginning of a critical analysis of my preconscious. This analysis reignited my sense of resolve to engage in critical action research that challenges how racialized systems oppress African American students' opportunity. In all of this, I drew parallels of oppression among my opportunity as a student, my students' opportunities, and my research.

As with all critical studies, this study critiques issues relating to power in systems, specifically those who are privileged and marginalized in education. To that end, I considered insider status, positionality, identity, framing, and the importance of my reflexivity as it relates to the study (Merriam & Tisdell, 2016). My positionality discussion underscored the importance of maintaining a post-reflexion journal throughout this study. Regularly revisiting the journal helped me understand and question how new information and preconscious understandings could shift my positionality and framing. This discussion of positionality served as my initial post-reflexion statement. In it, I described my beliefs and perspectives of education, race, isolation, and oppression as well as how they were framed by experience. Engaging in a continuous interrogation of my beliefs, perceptions, and perspectives ensured that the phenomenon, how African American students experience science, remained at the center of the study (Merriam & Tisdell, 2016; Vagle, 2018).

Ethics

In this section, I address how this study met the ethical principles and applications for research involving human subjects. Before the onset of the study, I obtained Institutional Review Board (IRB) approval from the University of South Carolina. Since my study did not use data from my students, or any students in my school district, I did

not need local district approval. My school district reviewed the proposal and deemed full review unnecessary.

Once I obtained IRB approval, I identified and invited five African American college students who had attended high school and were likely accessible for interviews to participate. To honor the ethical principle of respect, I asked the participants, each of whom were 18 years of age or older, for written informed consent (Creswell & Creswell, 2018). Since the participants were 18 and older, parent or guardian consent was not required. Of the five students I invited, three agreed to participate.

I used informed consent to explain the general purpose of the study, the mode of participation, that participation is not mandatory, and that they could rescind permission at any time. I provided written and verbal information in English, the preferred language of each participant. Informed consent was essential to upholding the autonomy of participants because it allowed them to judge whether the risks of participation were worth the progression of knowledge (Bloomberg & Volpe, 2019).

To ensure participants' privacy, confidentiality, and anonymity, I replaced their names with pseudonyms throughout the interview transcripts. The transcripts were stored in a password-protected document stored in a password-protected database. The coded transcripts were scanned and saved to the same database. The paper copies were shredded. I am the only one with access to the documents and the databases. After five years, I will destroy all of the data. At the end of each interview, I reminded participants of my intent and methods to maintain confidentiality and offered to follow up by sharing the abstract of my dissertation with them.

Summary

This critical post-intentional phenomenological action research study explored the phenomenon of how African American students experience science and considered how knowledge of those experiences can inform a change in my science pedagogy. Guided by a critical paradigm, this study critiqued the educational system that has shaped experience and formed reality for students. Unlike traditional phenomenological studies, this study did not limit itself to identifying the essence of students' experience. Once parallels of experience were identified, I examined what was not a part of those parallels for new ways of understanding African American students' experiences with science. This data analysis process is the reduction part of phenomenological reduction, and returning to the data after the reduction, to examine what is left behind, made the process post-intentional (Vagle, 2018).

My problem of practice stemmed from my unilateral assumption that all African American students shared my perspective of education, that isolation is normal. Through phenomenological interviews that detailed the phenomenon, I elevated students' counternarrative. Driven by a desire to challenge the existing racialized system of science education that is documented in research, I employed an action research design to explore how knowledge of African American students' experiences with science could inform changes to my practice. I used an observation journal to document and reflect on the changes I made, and through a post-reflexion journal that captured my positionality and reflexion, I continuously interrogated my perspective to ensure my analysis centered on students' experience.

The next chapter will report and discuss findings from data that are meaningful in understanding how African American students experience science and how that understanding can inform transformative changes to practice.

CHAPTER 4

FINDINGS

The purpose of this study was to understand how African American students experience science and to explore how that understanding could inform a change in my practice. As discussed in earlier chapters, the underrepresentation of African Americans in science reflects a broad, systemic problem at the intersection of race and science. Historically, the erroneous theory of deficiency, which problematizes African American students, has been used to explain the underrepresentation of African American students in science (Gordon, 2020; Ladson-Billings, 2009). However, critical race theory and Black existentialism assert the cause emerges from a discrepancy between how African American students see themselves and how others see them at the intersection of race and education. This discrepancy widens with curriculum and pedagogy that restricts opportunities in science (Brown & Jackson, 2013; Gordon, 2000).

The dearth of diversity in science that contributes to limited opportunities for African American students to enter science careers and achieve economic equality necessitates an examination of a precursor to science careers, high school science education (Torraco, 2018; Wang, 2013). By critically examining my teaching, I found that my problem of practice originated in my acceptance and use of assimilationist practices and not in the deficiency of students. By acknowledging one way of learning and knowing science, my color-blind practices undermined African American students' intersectional identity and reinforced underrepresentation and inequity in science. In

classrooms that reinforce the presumed irreconcilability of African American students' identity with science, African American students receive the message that science is not congruent with their identity, and they do not persist in science.

Students' perceptions of classroom experiences contribute to the development of their academic identities. When students believe their voice and experience are not valued or respected, they fail to identify with classroom learning (Hazari et al., 2015; Ladson-Billings 1995). Assimilationist practices produce experiences that, in conjunction with underrepresentation in advanced math and science classes, send a message that math and science are not congruent with the African American identity (Wang, 2013). Without an understanding of the importance of students' experiences in the context of science, I did not produce experiences that contributed to the development of African American students' science identity. Once I realized this, I designed this study to explore student experience and I used it to inform a change in my practice.

My critical analysis of the intersection of race and science engaged intersectionality, a critical race theory (CRT) concept. In a discussion of CRT in education, Ladson-Billings and Tate (1995) argue that the intersection of race and property becomes an analytic tool when it is used to understand inequity in education. Therefore, analyzing and understanding African American students' experiences at the intersection of race and the property of science education has allowed me to understand the source of underrepresentation and inequity in science. My data analysis is holistic and richly descriptive, illuminating a complex and obscured reality in science for African American students (Fraenkel et al., 2015).

In this study, critical post-intentional phenomenology allowed me to suspend dominant narratives so obscured counternarratives could be normalized (Guenther, 2020). Action research provided a method through which I illuminated and translated obscured narratives into action. The actions I took as a result of my data analysis disrupt oppressive and restrictive patterns in science education (Guenther, 2020). Uniting critical post-intentional phenomenology with action research resulted in a critical post-intentional phenomenological action research methodology that used CRT's tool, the counternarrative, to craft action that addressed social justice.

The findings of this study answer the following research questions:

1. How do African American high school students experience science?
2. How can learning about African American students' science experiences inform my practice?

By answering these questions, I provided insight into the relationship between intersectional identity and pedagogy that expands science opportunities for African American students and increased diversity in science.

In this chapter, I organized my discussion by research question. As there are two research questions, there are two halves. Within each half, I elaborated on the question, provided a brief review of the data analysis process I introduced in Chapter Three, presented the data, and concluded with an interpretation of the data. I concluded this chapter with a broad summary of the findings and a segue to Chapter Five.

Data Presentation and Interpretation by Research Question

The findings from the data collected during this study are presented by research question (RQ). Since this is not a case study, I did not present data by participant. Instead,

I extracted data from participants' interviews and organized it by how it addressed the phenomenon. As a phenomenologist, I emphasized the phenomenon of how African American students experience science and not individual cases (Efron & Ravid, 2013). Unlike other qualitative methodologies, in phenomenology, and as I did here, data analysis treats all pieces of data equally (van Manen, 2014). This means every data piece was weighted equally and did not have to repeat to be significant. This method honored the uniqueness of individual students' experiences in science.

In a post-intentional phenomenological study, the essence of experiences shared by participants is not the focus of the study; however, it is necessary to identify new ways of thinking about the data. Post-intentional phenomenology looks beyond the essence of experience to the edges where new ways of thinking emerge (Vagle, 2018). Therefore, categorizing the interview data was necessary for identifying what data was left behind and new ways of thinking. This final analysis resulted in an understanding that informed the intervention design for addressing the second research question.

RQ 1: How Do African American High School Students Experience Science?

African American students who have experienced high school science are the embodiment of this phenomenon. Their experience within the racialized system of science education is unique and shaped by the context of science education (Vagle, 2018). Therefore, they are the expert participants who were best positioned to provide data to answer my first research question. To collect this data, I employed qualitative interviews to capture three students' nuanced feelings and perspectives of how they experienced science (Merriam & Tisdell, 2016). Of the male and female African American college students I invited to participate, the three who agreed were all female. I

have given these three students pseudonyms: Claudia, Gillian, and Shirley, the first names of African American women who have earned a Ph.D. in physics.

To build competitive resumes for college, the participants took science all four years of high school. Claudia is a quiet, reserved young woman who attended a private, coed Catholic high school in Maryland and is now a community college student with an undecided major. While in high school, she was enrolled in a program for students who are diagnosed with attention deficit disorders or anxiety. Claudia's ongoing struggles with anxiety make it difficult for her to attend a four-year postsecondary school. Gillian is an outgoing, talkative, and passionate young woman who "respects people who respect me." Gillian attended a highly ranked public high school in Maryland and now attends the University of Hawaii, where she is majoring in natural resources and environmental management. Shirley, like Claudia, is also a private Maryland Catholic high school graduate, but her school was exclusively female. Shirley now attends Salisbury University, a public University in Maryland, where she is majoring in elementary education. Shirley is more reserved than Gillian but more extroverted than Claudia.

Despite the participants' shared characteristics of college enrollment and race, to ensure that they are understood as individuals with unique experiences, it is important to note their differences. In addition to background questions, I asked each participant about their experiences in each of the four science courses they took in high school. While in high school, all of the participants took biology, chemistry, physics, and a science elective such as International Baccalaureate science, forensic science, or environmental science.

As explained previously, each unstructured recorded interview was transcribed verbatim. Then, I used reduction to code and organize experiential data with the phenomenon from the transcripts into negative, neutral, and positive clusters of meaning. As a post-intentional phenomenologist, once I organized the data into clusters, I returned to the original transcript to examine uncoded data or data that was left behind because it did not fit into any of the clusters (Vagle, 2018). Post-intentional phenomenologists believe new ways of thinking about a phenomenon are embedded in uncoded data and are essential to pushing our understanding of phenomena into new theories or ways of thinking about theory (Vagle, 2018). The next section, presentation of data, begins with a presentation of the initial clusters of meaning that emerged from the data followed by a presentation of the new ways of thinking that emerged from the uncoded data.

Presentation of Data for RQ 1

I organized data from the interview transcripts into three clusters of meaning based on participants' experiences and named them *data categories*. As shown in Figure 4.1, the data categories of negative, neutral, and positive align well with the concept of the mathematical number line. In math, negative numbers are to the left of zero, and positive numbers are to the right. Negative numbers are associated with subtractive or *less than* concepts, while positive numbers are associated with additive or *greater than* concepts. Neutral data is the reference point where nothing is added or taken away but away from which negative and positive move. Students' experiences accumulated into three categories based on how students felt about their science classes.

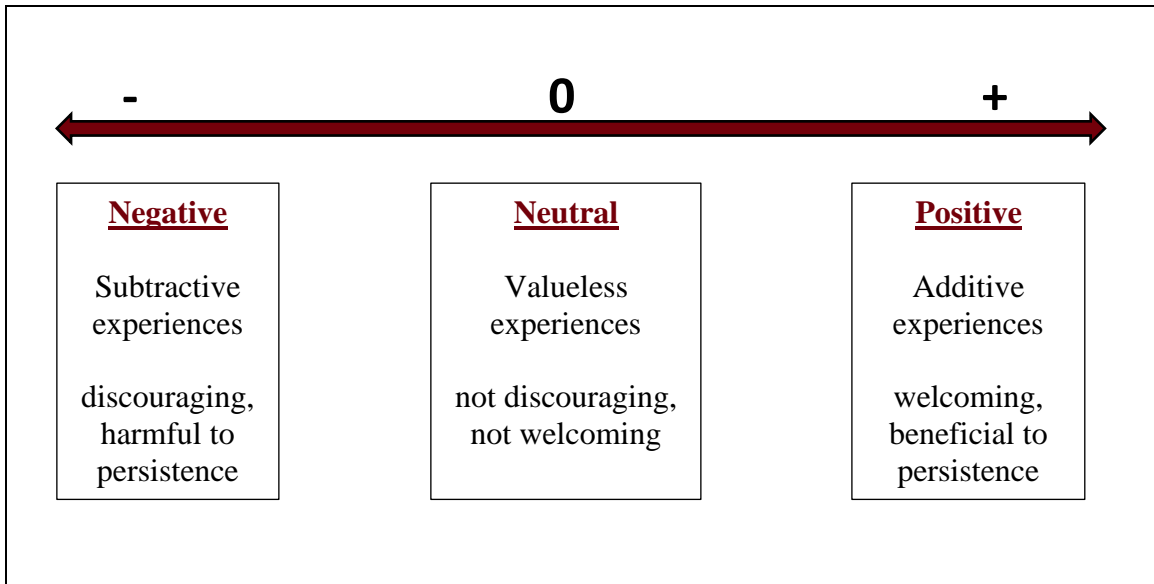


Figure 4.1 Data Categories

Negative Experiences. I categorized experiences that oppress and undermine growth at the intersection of science and race as negative, to the left of neutral. These experiences oppress and undermine growth at the intersection of race and science because they encourage a sense of marginalization and isolation in African American students. Students who sense that science is not congruent with their racial identity neither develop a strong intersectional identity nor persist in science.

Shirley commented that her negative experiences with science were linked to the science teacher's practices. In biology, where her teacher publicly identified who was doing well, Shirley explained, "I was never one of those kids so, like, I always felt kind of like, excluded." This excluding experience pushed Shirley to the margins where she felt isolated and alone. Ultimately, Shirley earned an F in biology.

Gillian recalled her experiences clearly as she described how she felt after her chemistry teacher refused to help her:

I got really upset with him and I, I remember like crying during my preps just because I was so embarrassed that he would call me out and he would, he would like, he had his favorite students, which were like all the baseball players, all the White kids that were like all baseball stars, and he loved them and he was a baseball fan so he really only cared about his little clique of students.

Gillian's words "that he would call me out" reflect her experience of isolation in this chemistry class. Isolation is part of a negative experience because it undermines and oppresses the congruence of race with science. In spite of this incident, Gillian persisted in trying to get help from her chemistry teacher only to hear him say, "I don't know how I can help you. You just really don't understand anything."

As her chemistry grade declined, Gillian found herself physically marginalized as well when she was assigned to a seat in the back of the classroom. During her time in that seat, she noticed that "anyone who basically got below a C on like the first couple exams, he would place in the back and most of it was like Black kids." Even though Gillian is now majoring in science, specifically natural resources, and environmental management, she explained that she "still hates chemistry to this day" because these experiences in high school chemistry left her feeling "stupid," "embarrassed," and "belittled."

Claudia's negative experiences surrounded the concept of respect. In describing her feelings about watching students manipulate the biology teacher, by claiming they had turned in work when they had not, Claudia was appalled and angry. Claudia explains respect in this way, "I would never disrespect my teachers like that. I never did because

they are, my, they're, the adults to me.” For Claudia, a lack of respect between the teacher and the student produced an uncomfortable, negative experience. She felt that even though she withdrew and isolated herself from other students and the teacher and tried to do her best, other students earned higher grades through manipulation. Seeing that the expectations were not even for all students angered Claudia. Both she and Gillian shared that in classes where they felt respected by the teacher, they also respected the teacher. Without respect, they did not feel that the class was a safe environment for taking intellectual risks.

Neutral Experiences. In this study, experiences categorized as neutral were those that did not give students a strong feeling about science. They were valueless but not without consequence. Even seemingly harmless, neutral classrooms can derail persistence in science. Wang’s (2013) research reveals how classrooms that fail to engage African American students dissuade them from pursuing science. While the experience and the meaning participants attach to it is different, the result is the same as for negative experiences.

I considered placing neutral experiences in the negative category because these experiences passively reinforce students’ existing disconnect with science. However, I decided to separate them to make the distinction that neutral experiences, such as color-blind practices-that claim to be neutral, passively, rather than actively, undermine and oppress the intersectional identity or race and science.

Shirley noted her neutral experiences with comments such as “I liked my teacher but I feel like most of her instruction was spent on classroom management.” Claudia described neutral experiences as “dry” while Gillian noted one science class experience

as having no science. Gillian shared that “Either people had headphones on or you’re doing the work on your own.” The participants’ collective sense of wasted class time undermined their ability to connect with science.

Positive Experiences. I categorized experiences that nurture growth at the intersection of science and race as positive, to the right of neutral. These experiences nurtured the intersectional identity because the students felt heard, and safe enough to take intellectual risks. Intellectual risk-taking comes in different forms, but in this study, I used the term to describe the willingness of students to engage with the class, despite a chance for failure. Students who engage in intellectual risk-taking enjoy learning, are more resilient when faced with academic failure, and are more academically successful (Bal-Incebacak et al., 2019).

Claudia felt strongly that her most positive experiences with science stemmed from relationships with teachers who possessed knowledge of their students. She felt her chemistry teacher “knew how a lot of us learned and just adapt[ed] the class to everyone’s learning style.” She felt she “didn’t have to feel embarrassed about answers and no one would like laugh.” As a result of the comfortable and safe environment, she excelled in chemistry so much that she shared, “I won an award that year, science student of the month.”

Shirley’s comments on her experience with feeling understood indicated that for the first time, she felt confident in science. Shirley vividly recalls that she had “never heard from a science teacher that, like I had potential to like, do better. And so, like she told me that and like, I actually like, believed it.” This moment was so significant for Shirley that she shared that “when she told me that like, I had potential, I, the first thing I

did was text my mom. (laughs).” When I inquired further about what experiences nurtured her confidence in chemistry, she said that during class, she “didn’t feel embarrassed or anything. It was kind of like normal conversation. Like no pressure or anything, just talking about something that like I cared about.”

The concept of being understood was repeated by Gillian, who shared, “I was so myself and she’s still rewarding you for being you...that really made a difference.” Gillian felt positive about her biology course because she felt that this teacher was “one of the only teachers that actually enjoyed my conversation.” The experiences that emerged from being understood promoted students’ confidence in science. This confidence was reflected in the ease and comfort with which students would engage in intellectual risks. These experiences are positive because they nurture the intersection of race and science.

These categories are based on three clusters of meaning that emerged from my analysis of interview data. Neutral experiences are valueless, while negative experiences reinforce marginalization and isolation, but both undermine the intersectional identity of race and science. Positive experiences reinforce the intersection of race and science because students feel understood and are confident enough in the classroom to engage in intellectual risk-taking. Despite this detailed analysis, there were pieces of data that did not fit into these categories. I have named these pieces of data lines of flight.

Lines of Flight. Data that did not fit into the three categories became two lines of flight. These lines are the result of a post-intentional examination of how the phenomenon evolved with context and experience, how the participants changed with the evolving phenomenon, and how the participants viewed themselves in relation to the

world (Vagle, 2018). It was not appropriate to make these lines of flight part of the initial clusters of meaning. Even though the lines describe how the participants experienced science, they flee the original idea of positive, neutral, and negative and signal how the experiential phenomenon evolves. The categories for negative, neutral, and positive student experiences are defined clearly and statically, via a traditional, phenomenological method, but the lines of flight are evolving. Data for each line overlaps and the lines often entangle as they produce a new understanding. This new understanding suggests that how African American students experience science is fluid and dynamic and evolves as individuals interact with changing contexts and gain experience. Figure 4.2 illustrates how the two lines of flight escape my original way of thinking about the phenomenon. I have named these lines of flight *teacher's preconscious* and *equitable dialogue*. In the following discussion, I will use interview data to trace both lines of flight.

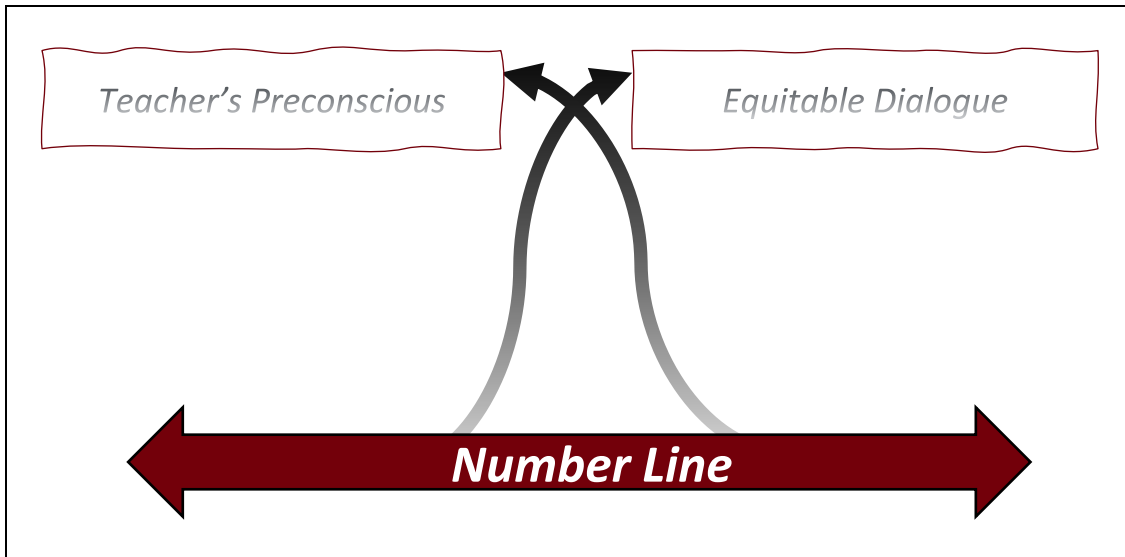


Figure 4.2 Lines of Flight. Two curved arrows represent entangled lines of flight. The arrow's gradient and the font inside the freehand boxes at the top, signal a new line of thought (flight). Freehand boxes around the names of the lines of flight suggest that the thought has been captured in a moment of evolution.

Presentation of Data for the First Line of Flight, Teacher's Preconscious. As I read through the transcripts a third time, I noted Gillian's comments about her learning style and how it did or did not align with teachers' preconscious understandings of what makes a good student. While I perceived these comments as significant, they did not fit into one of the three categories. Gillian reflected on her self-described, talkative way of learning as, "that's just how I like to be engaged and I like to be engaged because if I'm not, if I'm not talking in your class, it means I don't care." Gillian believed that her learning style impacted what science teachers thought of her: "I just thought maybe the issue was that teachers just didn't like me." She connected this feeling with her observations of her chemistry teacher's negative responses to her way of learning by assigning her seat, along with other African American students, to the back of the classroom. Gillian notes that her biology teacher was "one of the first teachers that actually enjoyed me being engaged," which meant that she was "one of the only teachers that actually enjoyed my conversation."

Claudia also alluded to the relevance of the teacher's understandings of science in her description of her physics teacher. She notes that her physics teacher "taught us well." When I probed to find out what that experience entailed, Claudia shared that "She would give us notes, we'd fill in the blanks for, we'd do a PowerPoint." In spite of what Claudia shared, she felt as though "the content wasn't, didn't stick with my brain very well. I'd feel like I didn't understand it a lot. I would ask questions, but it was, I don't know, it just wasn't my subject." Claudia went on to explain that despite what she felt was competent instruction, "I just think she didn't think she needed to connect." To Claudia, teachers who value a sense of connection provided the best learning experiences. Claudia felt that

the physics teacher's disregard for connecting with students was a contributing factor to Claudia not seeing herself as a strong physics student. To Claudia, it seemed that the teacher's preconceived notion of what makes a good physics student meant that instruction was neutral and absent of a personal connection.

At first, this line of flight seemed to be less evolved in Shirley's transcript. Shirley shared an experience when she returned, two years later, to the teacher with whom she had failed biology for an environmental science course. When Shirley discovered it was the same teacher, she was disappointed, but her passion for the subject overrode her disappointment, so much so that she explained that she was willing to change how she learned this way: "even if I didn't get a lot from her, like I could get a lot from like, reading the book and taking the class." This reflects Shirley's willingness to assimilate and adopt a different learning style to be successful in this class.

Fortunately, Shirley was pleasantly surprised to discover that the teacher seemed to have adopted a new understanding of learning science. This understanding embraced Shirley's self-described shy curiosity and allowed her to grow. She describes this experience through a class conversation about the Paris Agreement where the conversation flowed so easily that it was "like I was just talking to like a bunch of friends about like the climate. But, I didn't feel like embarrassed or anything. It was kind of just like normal conversation. Like no pressure or anything, just talking about something that like I cared about like other people." Shirley felt that the teacher's value for an environment that embraced diverse ways of learning and demonstrating knowledge let her feel comfortable taking intellectual risks.

Presentation of Data for the Second Line of Flight, Equitable Dialogue. My second line of flight emerges from the participants' comments about being able to get help from teachers. Shirley's comment that "I had a, like an easier time understanding the material because my teacher was willing to help" underscored how a student's perception of a teacher's willingness to help nurtured a science identity. Gillian's experience with her chemistry teacher who told her, "I don't know how I can help you. You just really don't understand anything," contrasts her experience with her biology teacher, who "answered your questions really thoroughly and then if you still didn't get it, they would like, you know, they'd be like, okay, well come to me after to class to talk about it." As seemingly opposite as these responses are, they communicate the significance of students' perceptions of teachers' willingness to listen and help students.

To develop a full understanding of what getting help looks like, I asked the participants to describe what they experienced when this did and did not happen. As we explored their experiences, I realized the participants were describing the teacher's willingness to communicate via equitable dialogue that centers on the student's feeling heard. For example, Claudia noted that her physics teacher gave a lot of notes and worksheets and that despite asking questions, she felt it "didn't stick in my brain very well. I'd feel like I didn't understand it a lot." She attributed this to the teacher's disregard for listening to students.

When I asked Shirley about what made environmental science so much better than her biology course, she shared it was "just so interesting to just like, learn." When I asked Shirley more about what this experience looked like, she shared that the teacher "would stop a little bit early and we would just be able to sit and talk and not just to like

each other but like to her [the teacher].” It was through these discussions that Shirley developed a deep understanding of the 2016 Paris Agreement and recognized her joy for thinking deeply about issues. She was comfortable taking intellectual risks using dialogue because she felt “like I was just talking to like a bunch of friends about like the climate.” This quote is significant because it also suggests that an important part of this dialogue was Shirley’s opportunity to engage in conversations that she perceived as equitable. The word “friends” suggests a flattened hierarchy and an equitable distribution of power.

Gillian noted that in the science classes where she did well, students had “a lot of time to discuss with your classmates,” which “helped a lot because you could kind of see from another student’s perspective.” Claudia, too, noted that her best science experiences occurred in classes where students spent time with the teacher “talking about what we wanted to do” during which she “didn’t have to feel embarrassed about answers and no one would like laugh or anything if there was a stupid question.” For Claudia and Shirley, experiencing comfort while engaging in dialogue was essential to taking intellectual risks. Gillian, who describes herself as talkative, refused to compromise this quality in herself. In environments where she could engage in dialogue, she felt recognized and experienced resonance with the subject. To her, this way of learning was better because she felt that dialogue tailored the material to her way of learning.

The willingness of teachers to engage in dialogue that was reciprocal and equitable made memorable experiences for Gillian, who spent lunch with her friends in the biology teacher’s classroom. During that time, Gillian felt that “if I did have like biology question homework, she would, you know, help me answer them.” However, her dialogue with the teacher was not limited to coursework as she explains that, “even if

there wasn't something that we learned in biology and there was a cool biology fact that we knew or that we wanted to know, she was really cool about answering that. So, she was just like a, a relatable type teacher." Being "relatable" suggests an equitable distribution of power and connectedness with the teacher who, to the students, is representative of the subject.

Interpretation of Data for RQ 1

Data addressing the first research question led to an interpretation of how teachers' preconscious frames science experience for African American students. When teachers' practices embody diverse, preconscious understanding of science, students' experiences nurture and reinforce the intersection of race and science identities. This data suggests which understandings and practices enhance opportunity in science for African American students.

Interpretation of the First Line of Flight, Teacher's Preconscious. This line of flight illustrates how the phenomenon of how African American students experience science evolves with context and experience. With each experience, the participants changed how they viewed themselves and their position in the world. The participants' comments on how they learn suggest that science teachers' preconscious understandings of learning and knowing science communicate acceptable ways of learning and knowing science. Gillian captured this perfectly in how she explained that her learning style involves a lot of talking, which she thought caused teachers to dislike her. Gillian internalized this to mean that her teachers did not think talkative students were science students. Both Banks' (2016) and Ladson-Billings' (2009) assertions that we preference those who are like us suggest that teachers whose preconscious values only one way of

learning and knowing science may preference styles that were acceptable when they were students. Teachers' actions are an embodiment of their preconscious understandings, and they communicate to students, before students engage with content, who is preferenced in the classroom.

How the participants experienced science was framed by explicit and implicit teacher actions that influence both the student's perceptions of self and how they see their position in the world. Based on these experiences, students decide whether science is congruent with their identity. They develop an image of who is a good science student and who is not. I named this first line of flight teacher's preconscious because I suspect teachers are either unaware of their preferences or they may not be aware of how their practice embodies their preferences.

Interpretation of Data for the Second Line of Flight, Equitable Dialogue. The practice of equitable dialogue is directly linked to how students felt about a subject. When students felt that they were heard, they felt positively about the subject. For all three participants, in classes where they did not feel heard, all three disliked the topic. Being heard means classroom dialogue is equitable and power hierarchies are flattened. When teachers' preconscious conceptions of science value equitable dialogue, they employ practices that nurture the growth of the intersectional identities of race and science.

Equitable dialogue promotes experiences with science that value the whole student as they are now. Through a preconscious understanding that recognizes diverse ways of learning and demonstrating knowledge of science, culturally relevant teachers maintain fluid and equitable relationships with students that honor the whole student

(Ladson-Billings, 2009). When African American students experience being at the center of learning and knowing science, rather than isolated in the margins, they feel that science is congruent with their racial identity.

The participants of this study perceived that dialogue was equitable when they were heard, which supported students' sense of self in the context of science (Ladson-Billings, 2009). Positive perceptions of science emerged from experiences where the participants felt heard and in which communication was reciprocal without reinforcing power hierarchies. How the students experienced science, how they changed as a result of that experience, and how they perceive their position in science evolved with the quality of equitable dialogue they had with the teacher.

Communication, in the form of dialogue, alludes to equality because it suggests engaged parties have equal opportunities to speak and be heard (Rudduck, 1993). Based on my data, when teachers employed practices that reflect the properties of dialogue, the participants used words like *amazing*, *comfortable*, *connect*, *enjoyed*, *freedom*, *fun*, *great*, *personal*, *relatable*, *respect*, *safe*, *super-engaged*, and *understanding* to describe their experiences. Many of these words were repeated by the student-participants in Ladson-Billings' (2009) research on teachers who model the social relation dimension of CRP.

The social relations dimension of a culturally relevant classroom challenges the power hierarchies that are reinforced by traditional, assimilationist, color-blind practices in science education. When teachers employ traditional science teaching practices, such as Claudia's physics teacher who disseminated content via worksheets and PowerPoints, the role of the teacher is that of a powerful authority figure or holder of knowledge (Ladson-Billings, 2009). In classrooms where Claudia, Gillian, and Shirley excelled in

science, the teacher assumed a more equitable position and adopted practices that promoted equitable dialogue. As a result of their experiences with equitable dialogue, the participants' perceptions of science and their position in relation to it evolved.

Both lines of flight show how these new understandings are fluid and evolve with the changing participant and context. For example, after Claudia's intense experience with chemistry, she had high expectations for physics. If the courses had been reversed, and she had physics-a course she did not enjoy first, her experience with chemistry may have been different. The concept of how the order and context of experience can cause a sudden shift in the evolution of a phenomenon reinforces conceptualizing this data as a line of flight. Just as barn swallows chasing insects can execute sharp changes in direction, so can students' experiences with science. As the order and context of experience change, so does the outcome. This new way of thinking moves my understanding of experience away from positive, neutral, and negative to a deeper understanding of the interplay of understanding, practice, and experience that influences the direction of a phenomenon's evolution.

RQ 2: How can learning about African American students' science experiences inform my practice?

Some of the science teachers at my school complain that many of their African American students are not engaged. Anecdotally, I hear teachers blame the student's cell phone, the student's value for education, the student's preparation for learning, and other things, for students' lack of academic achievement. These complaints amplify the deficiency theory that identifies students' deficiencies as the reason for their lack of achievement. In Chapter Two, informed by Black existentialism, CRP, and critical race

theory, I began thinking about a different reason, one that includes classroom experiences as influential to students' intersectional science and race identity.

To explore how students' experience influences intersectional identity, I needed to know more about how African American students experience science. My first research question explored how African American students experience science. To answer my second research question, I drew on my interpretations of the first question to inform changes in my practice. The resulting intervention allowed me to explore practices that reinforce students' intersectional race and science identity.

Data from my first research question suggested teachers' practices emerge from their preconscious conceptions of science. Practices that promoted equitable dialogue were the most influential to how the student felt about that particular subject. These practices value multiple and diverse ways of learning and knowing science. In science classes where Claudia, Gillian, and Shirley engaged in equitable dialogue, they also had the highest achievement.

To answer the second research question, I drew on data from two journals, a post-reflexion journal and an observation journal. As an African American science teacher who was once a science student, I believed it was essential to maintain a post-reflexion journal to interrogate my understandings of the phenomenon and ensure the changes I made in the classroom reflected the phenomenon of African American students' experiences and not my own (Vagle, 2018). I used my second journal, an observation journal, to record how I changed my practice and my reactions and reflections on the changes (Durdella, 2019; Merriam & Tisdell, 2016; van Manen, 2014). In this journal, I

also documented the thinking I used to transform my interpretations from my first research question into practice.

Presentation of Data for RQ 2

My analysis of the interview data informed the design of the intervention. Informed by the data and CRP, I emphasized the use of equitable dialogue in my practice to create a science classroom experience that nurtured the intersection of race and science. To ensure the dialogue was equitable, I focused on listening to students for the purpose of paraphrasing and asking probing questions. My goal was to center the student and shape my instruction around hearing what they needed. Since these practices occurred in different ways, I separated them into three social contexts: individual, individual in a group, and whole class.

Figure 4.3 is a visual representation of how I organized the changes to my practice that formed the intervention. Each rectangle represents a social context and the horizontal arrow illustrates the use of equitable dialogue across all contexts. Throughout the intervention I recorded my activities and reflections in an observation journal. My detailed descriptions were centered on my actions and my observations. As I discussed previously, I was not permitted to record student data. With student data, I could have constructed a more holistic description of how students experienced changes to my practice.

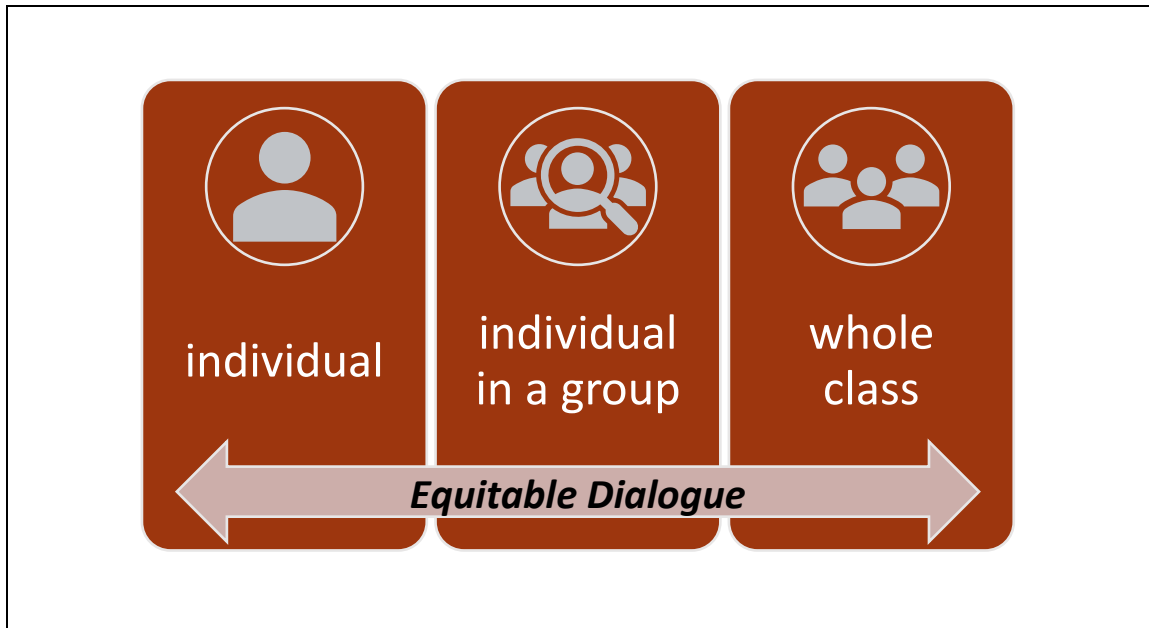


Figure 4.3 Organization of Changes to My Practice

Individual. My observation journal documented a series of dialogues I had with an African American student who had a low grade in my honors physics class. It was clear to me that he knew why I wanted to talk to him, and I chose an approach that was different from the conversations I usually have with struggling students. I placed two assignments on the desk and shared my observations of his work with him. I noted the exceptional points he had made in the written sections and explained why they were excellent. I asked him what he wanted to do after high school, and we talked about it, based on what we saw, he thought he could do it. After a conversation in which I listened and clarified what he said with probing questions, we agreed he did.

This led me to ask him what was stopping him from turning in assignments. While he spoke, I listened, paraphrased, and asked probing questions. From these questions, we came up with two things I could do to support his goal to do better in the course. First, I could provide a quiet place at lunch for him to do his homework, and

second, I could check in with him verbally to see how he felt about his understanding of the work, specifically, when it was due and what needed to be done, before he left the room for the day.

From my observations, I felt the conversation was productive. I sensed the student felt heard and that we were a team in his success. I believe this because, by the end of the week, I noted a significant change in his grades and willingness to participate in class. In my observation journal, I wondered if “when quiet students are overlooked, they disengage quietly.” Even though a quiet student’s experiences in science might be different from Gillian’s, it seems that without equitable dialogue, all students’ achievement in science will flounder.

Individual in a Group. For this segment of my observation journal, I documented a lesson in which students were assigned a small-group task. The lesson, a lab on refraction, was designed to help students see how light bends as it travels from air through glass and back to air. After students collected data, they had to measure angles using a protractor. Informed by interview data analysis and CRP, I chose this lesson because it allowed me to engage in equitable dialogue with individual students as part of a small group. I intended to use equitable dialogue to engage in discussions of refraction, and I did this, but during class, a new and unexpected opportunity regarding the protractor presented itself and I pursued it.

Many students, being in advanced math, have forgotten how to use the protractor, and I usually start class by showing them all how to use it followed by another review at the group level. This is normally a small part of the lesson and was not the initial focus of my data collection. While I was teaching the lesson and again as I reflected on it, I

realized the significance of this part of the lesson and I shifted my focus to it. Part of post-intentional phenomenology requires that the researcher be flexible and willing to make changes as new knowledge is gained (Vagle, 2018).

This year, I forgot to show the students how to use the protractor before they began the lab. Many students still needed help using the protractor, but on this day, I helped by visiting individuals in groups and using equitable dialogue rather than using a traditional whole-class demonstration. In one instance, when a student asked me how to use the protractor,

I asked them to show me how they thought they would use it. The student hesitated and said, ‘I have no idea.’ I explained that I needed them to show me so I could figure out which way to teach them. When the student showed me how they thought it worked, I realized that there were multiple ways to use it correctly and that many unsure students just needed me to watch, ask them questions, and let them know if they were right.

From that point on, “each time a student asked me to show them how to use the protractor, I used the same strategy,” and I noted in my journal that “I didn’t have to return to anyone to show them how to use the protractor a second time.”

In my reflection on this activity, despite forgetting to review how to use a protractor with the class all at once, I commented on how smoothly the activity flowed. I noted how students were able to move quickly past measuring the angles to the bigger picture of analyzing their data. I wondered about my preconscious belief that, for years, I had been helping by explaining one way of using the protractor. Now, it seemed that my insistence on explaining my way of using a protractor had undermined students’

confidence. I began to understand how acknowledging multiple ways of doing a science-related task, such as using a protractor, is like acknowledging multiple ways of learning and knowing science.

Whole Class. In the past, I have introduced the concept of waves by giving notes. This journal entry describes a new practice, wherein I extended the concept of dialogue to whole class instruction. I began class by putting four vocabulary words on the board. I asked the students to dissect the words, look for familiar parts, and try to match it with what they already knew. The goal was to attempt to define the word from prior knowledge and write it on a large whiteboard at their table. I did this four times; by the end of class we had introduced all 16 words.

One of the words I introduced was propagate. Students linked this word with the word propaganda and made connections to *Animal Farm*, a book they read in their eighth-grade English course. In *Animal Farm*, propaganda was a persuasive tool, and students remembered that propaganda was a way of distributing information. This definition is similar to a wave distributing energy as it propagates. In another example, students connected the word oscillate to an oscillating fan, which repeats its motion. In physics, when waves oscillate, they repeat a specific motion.

As a class, we synthesized the smaller groups' ideas into a whole class definition for each word. The students were excited to see how closely their definitions aligned, and they were eager to explain their reasoning to each other. As they did so, I listened and paraphrased their definitions. I also asked probing questions to make sure I understood what they felt was important. I wrote in my journal that in one class, a passionate debate erupted over the definition of oscillation. Students debated over how a traditional fan

with spinning blades and a more modern fan that blows air but only moves from side to side could both be oscillating. Several groups had written “that oscillation is a *time* and we linked it back to their examples of fans. Together we corrected it by describing [oscillation] as a *motion*.”

In my reflection, “I was struck by the level of involvement by every student. There was excitement in thinking beyond the classroom and bringing ideas back to physics.” Throughout this discussion, I sensed enthusiasm from my students as my questions seemed to spur more debate. At the end of it, I wrote that this experience was very different and “more engaging for both the students and me than it would have been if I had, as an authority figure, disseminated the information to the students via notes.”

Interpretation of Data for RQ 2

My interpretation of the data from my observation journal includes a discussion of my post-reflexion journal. To ensure my interpretations of the participants’ experiences informed an authentic change in my practice, I needed to recognize, state, and interrogate my science experiences. By doing this, I built an awareness of how my perspective frames what I see and prevent them from interfering with my data analysis.

As I analyzed the interview data and explored how it informed my practice, I felt unsettled. My findings were very different than my own experience. Realizing that students want to be heard was very different than my desire as a student to be left alone. However, as I combed through the data, it was clear that I had to push myself beyond a singular way of thinking about learning and knowing science. My new practices had to reflect an understanding that there are a myriad of diverse ways to learn and demonstrate knowledge of physics. After a lifetime of learning one way and a career teaching in the

same way, this was a challenging but incredibly necessary change for me to internalize and produce.

I had always believed students were heard in my class, but an in-depth, critical analysis of my practices and my post-reflexion journal revealed that was not true. Even more important than communicating and being heard, Claudia, Gillian, and Shirley wanted to be heard in different ways. Therefore, I decided I would explicitly incorporate equitable dialogue into my practice in different ways, through whole-class instruction, one-on-one, and as an individual who is part of a class.

In the whole class and as an individual who is part of a group contexts, I see that I had been deconstructing what students already knew about physics, only to attempt to reconstruct it in my way. By doing this, I was forcing students to fit their knowledge into my framework rather than fitting my knowledge into theirs. This undermined the confidence they brought to the classroom and sent a message that they were not good enough for science until they assimilated into my way. Now, I realize, on a visceral level, that hard and fast rules for learning and knowing science do not exist.

When I worked individually with the student about his grades, I reflected on “the need for students to experience excellence without deceiving them about their own academic achievement” (Ladson-Billings, 2009, p. 108). I let him tell me what he thought of his work, which allowed him to understand on a deeper level what it means that his work is exceptional. Through equitable dialogue, we worked together to construct a plan to help him succeed. The dialogue we engaged in included both speaking and being heard.

My preconscious understandings of science were embodied in practice that did not embrace communication that included students' being heard. Dialogue suggests turn-taking, which is closely associated with equality (Rudduck, 1993). Half of dialogue is listening, and listening broke down my bias for one way of learning and knowing science. The third dimension of CRP, conceptions of knowledge, asserts that culturally relevant "teachers see excellence as a complex standard that may involve some postulates but takes student diversity and individual differences into account" (Ladson-Billings, 2009, p. 89). When teachers take differences into account, students experience science as congruent with their sense of self.

As I return to the data and my analysis of it, I find myself asking more questions. What was it that produced more engagement for students in physics? My findings communicate the significance of the teacher as the one who frames academic experiences for students. Throughout the intervention, I changed my understanding and my practice, but I did not change physics. Instead, I changed how I framed the experiences students have with physics and my shift influenced the students' resulting perceptions of physics in practice. My emphasis on practice suggests my findings are not limited to physics but are transferrable to any academic content where African American students experience marginalization. This warrants an exploration of the implications of this research in chapter 5.

Summary

My problem of practice originated in my acceptance and use of assimilationist practices. In projecting my own experiences onto my students, I recognized one experience with science, learning science, and knowing science. Without an

understanding of students' unique and varied experiences in the context of science, I could not produce experiences that contributed to the development of African American students' intersectional race and science identity. I designed this study to learn how African American students experience science and link it to a change in my practice.

My first research question asked, how do African American students experience science? My initial analysis of data resulted in three categories of experience: neutral, negative, and positive. These categories were named by how they affected the intersectional identity of race and science. Subsequent analyses allowed me to identify two emergent lines of flight: teacher's preconscious and equitable dialogue. Through an analysis of interview data, I discovered that African American students experience science as validating and empowering when they can be who they are while concurrently feeling that they are academically successful. This happens through opportunities where students engage in equitable dialogue with teachers and peers. However, when a teacher's preconscious notions of science, restrict ways of learning and knowing science and exclude equitable dialogue, the student experiences science as marginalizing and isolating.

This complex and profound analysis of interview data informed how I addressed my second research question: how can learning about African American students' science experiences inform my practice? My analysis of data from the first research question suggested I must broaden my preconscious conception of science and informed an intervention centered on using equitable dialogue. African American students' science experiences informed a critical analysis of my post-reflexion journal and my observation journal that pushed me to uncover my preconscious notions of science. In making my

preconscious conscious, I recognized my false understandings of experience and how they were embodied in my practice. This critical analysis allowed me to employ equitable dialogue as an authentic tool in transforming my practice into one that centers the student in the classroom.

Through this study, I was forced to think critically about how African American students experience science. In this chapter, I have analyzed data and delineated how my unconscious beliefs imbued my practice and framed science experiences for African American students that undermined an intersectional race and science identity. In response, I have explored new ways of thinking and acting in the classroom that nurture and reinforce the intersectionality of race and science. As I have conducted this study and reflected on my analyses, new questions arise. What makes these findings important? What makes this new methodology valuable? How is the new knowledge generated by this study significant beyond my classroom? In the next chapter, I will explore how the meaning of the study's findings and the theories I thought with construct a new way of addressing equity in science.

CHAPTER 5

IMPLICATIONS

Du Bois (1903) spoke eloquently of African Americans' desire to "make it possible for a man to be both a Negro and an American...without having the doors of Opportunity closed roughly in his face." (p. 5). When teachers recognize one way of learning and knowing, only students familiar with that way, or students who assimilate, will find opportunity. Feeling free to identify as a successful African American science student requires science teachers who recognize a myriad of diverse ways of learning and knowing science. Without understanding the importance of students' experiences in the context of science, teachers cannot produce classroom environments that contribute to the development of African American students' science identity. Informed by a theoretical framework that examined how fields of power within systems restrict opportunity, I designed this critical post-intentional phenomenological action research study to challenge inequity in science. My exploration of student experience informed a transformative, and long overdue, change to my practice that centers students and values diverse ways of learning and knowing science.

Overview of Study

For 27 years, I taught science in a way that restricted African American students' opportunities in science. My preconscious beliefs that science was learned and taught in one way prevented me from acknowledging diverse ways of learning and knowing

science. By accepting and perpetuating the norms of the scientific status quo, I contributed to inequity in science. The purpose of this critical post-intentional phenomenological action research study was to understand how African American college students experienced high school science and how those experiences might inform a change in my practice.

The dearth of diversity in science that illustrates the restricted opportunities for African American students prompted my decision to examine the precursor to science careers, high school science education (Torraco, 2018; Wang, 2013). My research suggested that identifying and removing threats to students' identity, leveraging student experience, and developing students' critical perspectives of education were instrumental in nurturing the intersectional identity of race and science, which enhances students' achievement (Banks, 2016; Gee, 1989; Ladson-Billings, 2009). Therefore, I designed a study to examine how students' race, when it intersects with science, forms a unique experience and how that experience can inform an intervention of high school science teaching practices that nurture the intersection of race and science.

My research questions targeted data surrounding students' experiences with science and observations of my practice. I addressed both questions through a research design that allowed me to collect reliable data. The knowledge I gained from analyzing transcripts of interviews with African American students informed a profound critique of my pedagogy and an intervention reflecting transformative changes to my practice. This study sought to answer the following research questions:

1. How do African American high school students experience science?
2. How can learning about African American students' science experiences inform my practice?

To ensure that my analyses remained centered on students' experience, I maintained a post-reflexion journal and wrote an extensive positionality statement. These tools allow the action researcher and the post-intentional phenomenologist to address bias continuously (Herr & Anderson, 2015; Vagle, 2018). As I implemented the intervention, I journaled the activities and my reflections on them in an observation journal. Data from this journal allowed me to understand what science classroom experiences were significant to the construction of a robust intersectional identity of race and science in African American students. These changes expanded African American students' sense of opportunity and disrupted inequitable access to science.

My initial analysis of the interview data resulted in three categories of African American students' experiences with science. The categories—neutral, negative, and positive—were named by how they influenced the intersectional identity of race and science. Subsequent analyses allowed me to identify two, new, emergent lines of flight, teacher's preconscious and equitable dialogue. The lines of flight revealed how validating and empowering experiences have a powerful influence on African American students' sense of congruency regarding race and science identities.

Being a successful African American science student means that one's racial identity is not compromised so that one's science identity can take center stage; both identities intersect and exist in a mutually symbiotic way. Experiences that nurture this intersection occur when students have opportunities to engage in equitable dialogue with

teachers and peers. However, when a teacher's preconscious understandings limit ways of learning and knowing science and exclude equitable dialogue, the student experiences science as marginalizing and isolating.

The first set of data forced me to interrogate my preconscious beliefs and resulted in a broader conception of science. Through my positionality statement and my post-reflexion journal, I illuminated, interrogated, and analyzed my preconscious beliefs. With an overwhelming suddenness, I realized my preconscious beliefs did not include equitable dialogue. I had not listened to students' voice, and I had oppressed African American students' opportunity to engage with physics. My new awareness pushed me to recognize, with authenticity and permanence, the value of equitable dialogue as a method for centering students in my practice. With a sadness that transformed into a resolve to create change in myself and for others, I understood that I had been a part of the status quo that reinforced the oppressive and restrictive norms of science.

The intervention I designed to address the second research question was informed by interview data. My intervention repeated three practices across three contexts. In the contexts of working with an individual, an individual in a group, and the whole class, I implemented examples of equitable dialogue. From the first research question, I learned three practices that emphasize the equitable part of equitable dialogue. To practice equitable dialogue, I had to: listen actively, paraphrase, and ask probing questions of my students. As I conducted the intervention, I discovered a new level of student engagement. This engagement reflected experiences that reinforced and nurtured the development of strong intersectional race and science identities (Ladson-Billings, 2009;

Ladson-Billings, 2013). This chapter is dedicated to the implications of these findings and the action that emerges from them.

In this chapter, I described my reflections on the findings and methodology of this study. I begin with a discussion of the implications that extend from my findings of how African American students experience science and how it informs my practice. Next, I reflect and explore the implications of my methodology, the study's design, and its limitations. Included in the methodological reflection is a discussion of unanticipated occurrences, challenges, and constraints that impacted my study. Following this set of reflections, I provide a detailed description of how my new and significant knowledge has shaped the action I will take to remain empowered to challenge inequity in education.

Reflections on the Findings

In this section, I will explore how this study's findings have enhanced my understanding of both my problem of practice and my intervention. My findings generated two new ideas that flee traditional ways of thinking about African American students' achievement in science. The first line of flight, teacher's preconscious, refers to the obscured network of beliefs that inform a teacher's practice. The second line of flight, equitable dialogue, explores teacher practices and student experiences that nurture students' intersectional race and science identity. Each line of flight overlaps with and informs the other, and I will discuss how each line contributes to the implications for my problem of practice and intervention.

Implications of Key Findings for My Problem of Practice

This study generated two findings. One addresses teacher's understandings of science knowledge and the other centers on student experience. My first finding,

teachers' preconscious, describes the unarticulated beliefs and understandings teachers have of students and scientific knowledge. These beliefs and understandings produce practices that undermine or reinforce the intersection of race and science. The second finding, equitable dialogue, illuminated practices that flatten the power hierarchy and allow students to communicate and experience being heard. These experiences reinforce and nurture the intersectional identity of race and science. These findings combine to limit or expand African American students' opportunities for engagement with science. Together they have the potential to flatten the student-teacher power hierarchy that restricts opportunity.

Before this study, my practice preferred explaining over listening to students. While I believed I was helping students, I was communicating to students that they understood physics the wrong way and that to be successful, they needed to assimilate. My actions devalued the knowledge and sense of self students brought to the classroom. By communicating judgment on students' ways of learning and knowing science, I placed myself at the top of the power hierarchy and the students somewhere below. The closer the student was to my way of thinking, the higher they were in the hierarchy.

In my class, access to physics was inequitable. Students who entered class ready to learn in the way I acknowledged had an advantage over those who did not. Science continues to retain a dominant narrative that aligns with the majority race in science, sending the message that science is the property of White students (Harris, 1993). My problem of practice reinforced this narrative because it was rooted in my limited preconscious understandings of students and knowledge. The experiential and

interventional data analyses of this study support the idea of how a teacher's limited preconscious understanding of science may reinforce inequity.

White students, as well as those who could set conflicting identities aside, maintained a higher position in the hierarchy, and thus held an advantage in my physics classroom (Banks, 2016). During an analysis of interview data, I kept a post-reflexivity journal in which I interrogated how my experiences framed my actions. As I assigned language to my preconscious conceptions, the discordance between my beliefs and actions became apparent. This discordance was the impetus for an intervention that was informed by literature and participants' experiences.

In my classroom, students like Andrea, who did not conform to the dominant narrative, paid a high price. In a class where she felt forced to assimilate or disengage, Andrea chose to disengage. Now, I realize that disengagement does not necessarily mean earning poor grades. As Andrea continued to earn all As she never engaged with other students. Ultimately, by discouraging Andrea, an African American high school student, from engaging in science, my practice reinforced inequity and underrepresentation in science. Counternarratives such as Gillian's experience of realizing that all of the Black students in her chemistry class were banished to the back of the classroom strengthened my understanding of how teachers' practices frame experiences that can undermine the intersection of race and science for students. Narratives like these underscore the importance of a teacher's willingness to interrogate their beliefs through critical self-reflection.

Without this process, transformative changes to practice that are authentic and permanent are impossible. This study has added weight to the importance and necessity

of teachers' willingness to illuminate and interrogate their preconscious understandings of science. This work is the only way teachers can gain an inherent value for expanding their practice to include actions that frame supportive experiences for African American students at the intersection of multiple identities.

Recognizing one way of learning and knowing science means that other methods, such as those that include equitable dialogue, are not considered valuable. When dialogue is equitable, it flattens the power hierarchy among the participants (Rudduck, 1994). In my problem of practice, I believed the dialogue I had with students was equitable when it was not. Instead of flattening the power hierarchy, my dialogue with students reinforced it. To address the possibility of others' repeating my mistake, I chose to underscore the importance of communicating *and* being heard by adding the word *equitable* to the name of my finding. In my research, dialogue became equitable when I focused on actively listening to students for the purpose of paraphrasing and asking probing questions.

Through my research, I understand that science is validating and empowering when African American students perceive they do not need to compromise one identity for another (McGee, 2013). In the science classroom, this means that African American students can engage with science in a way that matches their identity. They do not have to adopt new ways of learning and knowing to feel authentically successful in science.

The implications of this study deepen my understanding of my problem of practice and enhance my ability to identify it when it repeats in broader contexts. The continued underrepresentation of African Americans in science and in earning science degrees (Semega et al., 2017) suggests a dominant, assimilationist narrative continues to imbue science. This narrative contributes to a cycle wherein a racialized system informs

teacher practices, which reinforces the system and repeats. Teachers can disrupt the cycle by deepening their understanding of African American students' experiences in science, critical self-analysis, and transformative changes to practice.

Now, I realize how my preconscious and self-deceptive belief that I was demonstrating value for diverse ways of knowing science obscured evidence that this was not true, and I consider how this discordance might repeat in my colleagues. It seems the current practice of broad professional development to train teachers on models like CRP does not promote permanent, transformative change to practice. Instead, it appears as though work at the personal and individual level is necessary for interrogating and changing preconscious beliefs. Critical self-analysis through the interrogation of preconscious beliefs is instrumental to teachers' professional growth and development.

I recognized how practices that frame restrictive science experiences for African American students are the embodiment of teachers' preconscious beliefs (including my own). Racialized systems shape these beliefs, and changing them requires deep, critical self-analysis and intervention-based action. The revelations I have experienced as a result of my self-analysis informed an intervention in which I engaged new ways of thinking and acting in the classroom. Through the intervention, I was empowered to nurture students' intersectional race and science identities and disrupt an oppressive cycle. Next, I will discuss the implications of the interventional findings.

Implications of Key Findings from My Intervention

The knowledge interest of action research necessitates the researcher explains what new knowledge will allow the researcher to do (Herr & Anderson, 2015). A study with an emancipatory knowledge interest, such as this one, centers on transformation

through critical self-reflection (Herr & Anderson, 2015). The knowledge I gained through critical self-reflection transformed my practice through an intervention that disrupted science norms. The practices I included in the intervention framed experiences that communicated value for the whole student, as they are now, thus nurturing the intersection of race and science (Ladson-Billings, 2009).

To bring clarity to the multiple ways equitable dialogue can exist in the classroom, I identified three contexts across which I implemented the intervention: individual, individual in a group, and whole class. This clarity precluded an oversimplified pedagogical intervention and pushed me to consider multiple applications for equitable dialogue. Equitable dialogue should not look the same in every context and should be informed by the social structure. Individual conversations innately have more room for turn-taking, while large-group discussions require strategies to ensure that all students' voices are heard.

Through my analysis of my observation journal, I realized that my initial uncertainty with implementing these practices was not in the practices themselves but my developing consciousness of diverse demonstrations of knowledge. As I applied the new practices in each social context, my uncertainty evaporated as I witnessed a new, refreshing enthusiasm in my students for learning physics. I believe that these experiences allowed students to feel that science is congruent with their racial identity and nurtured the intersectional identity of race and science. Instead of a controlling, oppressive, and restrictive experience, students enjoyed a sense of freedom in learning and demonstrating their knowledge of physics. I also recognize that teachers' uncertainty

in making changes will likely stem from shifting understandings of how science is learned.

Understanding of the importance of voice to the individual makes it easier to understand the significance of equitable dialogue to African American science students' sense of existential hope. I witnessed in my whole-class discussions of waves that when students felt heard, they were excited about science. This was reinforced by earlier data from Shirley's statement that the dialogue in her science class surrounding the Paris Climate Agreement felt "like talking to a bunch of friends," which illustrates how equitable dialogue enhances an existential sense of opportunity. This new idea is significant in understanding why equitable dialogue should be a highly valued practice.

When dialogue is genuinely equitable, students sense affirmation of their voice. Science teachers who embraced equitable dialogue made students feel triumphant, affirmed, and recognized. Students explained this feeling as *being heard*, which nurtures the whole self and lifts the veil, naturalizing the intersection of race and science. It is no coincidence that after my individual conversation with the student with low grades in physics, his grades and engagement improved.

The implications of my interventional findings underscore practices that move the work of accessing physics from the student to the teacher. Rather than the teacher requiring students to assimilate, students were free to engage with physics in a way that matched their identity. When teachers conceptualize and recognize diverse ways of learning and knowing science, they naturalize and nurture the intersection of race and science. This conception of knowledge, whereby teachers recognize diverse demonstrations of knowledge, is a hallmark of CRP (Ladson-Billings, 2009). As I

experienced, even teachers who believe they already hold this conception of knowledge must be willing to undergo a critical self-analysis to affirm the congruence of their beliefs with practice.

Connections: Literature and Key Findings

My literature review provided context, foundation, and an argument for exploring my research questions (Machi & McEvoy, 2016). In conducting a literature review for an action research study, I had to ensure the literature did not obscure new revelations (Herr & Anderson, 2015). Post-intentional phenomenology issues the same caution and addresses this issue by describing the literature review as learning about “theories I want to think with” (Vagle, 2018, p. 142). Both methodologies emphasize caution in working with literature to prevent it from obscuring new findings.

In this section, I have divided my discussion of the relationship between the key findings and literature into two halves. The first half outlines scholarly connections with my findings of how African American students experience science. The second half details how literature underscores the ability of my intervention to address my problem of practice. To maintain alignment with the study, my initial discussion of literature and experiential findings will be followed by a discussion of literature and the intervention.

Literature and African American Students’ Experience with Science

This study emphasized four components of CRT: race as a social construct, racism as a norm, intersectionality, and the counternarrative (Brown & Jackson, 2013; Ladson-Billings, 2013; Ladson-Billings & Tate, 1995). In Chapter Two, I explored how history has informed social constructions of race. Our understanding of race has framed educational practices that are explicitly segregationist as well as those that are implicit

and assimilationist. Since the *Brown v. Board of Education* ruling in 1954, the American educational system has eliminated *de jure* segregationist practices but not assimilationist ones. While Brown asserted that separate is not equal, implicit assimilationist practices reinforce a social construct of race that privileges one race over others, thus perpetuating racism as a norm.

Existing social constructions of race continue to inform educational norms, which reinforces a system that privileges one group over another, creating inequitable opportunities. Existentialism posits that individuals determine the structures and meanings of their reality, while Black existentialism argues that societal constructs of race restrict the freedom to do so. When Black students engage with an educational system that views them as deficient, the system controls their freedom to define their reality. When Gillian resisted her chemistry teacher's view of her as deficient, she was physically moved away from the source of instruction and figuratively moved away from the opportunity to define her success in chemistry. In her new seat in the back of the room, she found herself surrounded by only Black students while the White students sat up front. Gillian understood that to be White gave you access to the front row, chemistry, and an opportunity to learn. These practices embody teachers' preconscious understandings of science and reinforce the racialization of science education. Black existentialism is a discipline wherein we can name and challenge practices like these.

In the same way Du Bois' metaphorical veil referred to the separateness of being an African American and an American, the social construction of race separates African American students from science. The perceived incongruity of race and science weakens students' intersectional identity and perception of their whole self (Ladson-

Billings, 2009). Even though Gillian is majoring in science at the University of Hawaii, she shared that she “hates chemistry to this day.” In response to the perceived incongruency of two identities, students withdraw from the conflicting identity or compartmentalize it (Erikson, 1968; Tatum, 2017). Gillian withdrew from chemistry. Historically, American education policy has placed the onus of the achievement gap between Black and White students on Black students. In this study, I used the counternarrative to challenge the location of this responsibility and illuminate a new location, the teacher.

The counternarrative was a powerful methodological tool for developing my understanding of how African American students experience science as two lines of flight. Through interviews, participants named and described climates that reinforced a sense of inequity and those that nurtured their scientific interests. The counternarratives I captured reflected students’ deep frustration with being denied the opportunity to be heard when they attempted to demonstrate their knowledge of science to teachers. Their narrative challenged the dominant, normalized, narrative of the status quo that located science failure in the student.

The underrepresentation of African Americans in science is a product of assimilationist practices in the science classroom. As I discussed previously, assimilationist practices recognize one dominant way of learning and knowing science, thus devaluing and marginalizing other perspectives. In assimilationist classrooms, students are forced to assimilate or abandon scientific pursuits. In this study, when teachers’ practices embodied preconscious understandings that devalued equitable dialogue, African American students felt forced to assimilate. Both Claudia and Shirley

worked to fit into the assimilationist classrooms, but despite their efforts earned low grades. Gillian refused to assimilate and was physically marginalized.

Rather than recognizing that there are many ways of learning, Gillian saw herself as different than the normal student. She believed that teachers “just didn’t like me” and that she did not meet the normalized expectations for science students. Her story illustrates how teachers’ preconscious understandings, including social constructions of race in science, determine access to opportunity. Gillian was not only denied entry to chemistry but moved to the margins because her behaviors were outside the teacher’s perceptions of science norms (but within his social constructions of race). In the margins, she was not able to construct an intersectional adolescent identity of chemistry and race. Since adolescent identity informs adult identity, it is understandable why Gillian continues to hate chemistry as a young adult (Erikson, 1968).

Racial constructs inform broad systems, such as education, which in turn, inform a teacher’s preconscious understandings of race. When a teacher’s preconscious understandings value a singular way of learning and knowing science, the practices informed by those understandings cycle back to reinforce racialized systems. Students with diverse backgrounds who learn in alternative ways are burdened with the additional responsibility of learning science norms (McGee, 2018). Students who are unable to do so are deemed deficient. However, practices, such as equitable dialogue, reflect an understanding of science that includes diverse learners and diverse ways of learning and knowing science. Practices like equitable dialogue are essential to a robust intersectional identity of race and science. When students can embrace their full identity, while at the intersection of race and science, they find value in science.

Literature and the Intervention

Informed by an understanding of how African American students experience science, I turned to the curricular disciplines of social reconstructionism, multicultural education, and CRP to fortify the rationale for my intervention design. Throughout the intervention, my observations and reflections refined my understanding of how experiential data informs practice. The observational journal data I collected deepened my understanding of the disciplines and allowed me to engage in recursive and cyclical work to refine the intervention. Through literature, I developed an understanding of how curricular disciplines become tools for transforming practice to disrupt the norms for learning science.

Counts' (1932) conception of social reconstructionism pervaded the rationale for the intervention. My experience with Andrea was representative of my problem of practice. My disappointment and frustration with my ability to engage African American students with science was the origin of my desire to change it. By adopting Counts' position that it is a teacher's moral and ethical responsibility to work for social change, social reconstructionism justified the action I took to address my problem of practice. Throughout the intervention, I used equitable dialogue to reinforce the critical analytical skills students need to challenge inequity.

In the first social context of the intervention, the individual, I worked with one student, who had a low grade in physics, practicing analysis skills by examining his work for meaning. When we finished, he was able to cite evidence supporting the claim that his work was representative of a good science student. Critical analysis skills are essential to naming problems and planning action for change. By recognizing he possessed the skills

associated with a good student, he understood that his grade was not a limit to his ability to do well in physics. My moral and ethical responsibility to work for social change is embodied by actions that strengthen students' critical analytical skills.

Practices that reinforce inequity in science exist at both the individual and group levels. A system of reform that aligns broad systemic change to classroom practice is necessary to ensure permanent and authentic change (Banks, 2016). While Banks (2016) asserts that multicultural changes can be systemic, school-based, and classroom-based, my intervention necessitated a different application. My responsibility to engage in work that disrupts the status quo required change to align my beliefs with action. Rather than aligning school and classroom change, I aligned beliefs with action.

Multicultural education asserts that in education, one group is privileged (Banks, 2016). My preconscious beliefs upheld a different belief, that science, through color-blind practices, had removed the privileged status of White over Black students. The practices that resulted from this belief forced Black students to assimilate into the historically singular way of learning and knowing science dominated by White Americans. When my preconscious understandings became conscious, I recognized my beliefs were wrong. This intervention became the tool I used to explore how well my new practices aligned with my new beliefs.

The design of my intervention included practices that communicated value for diverse demonstrations of knowledge and learning physics. In my observation journal, I discussed the work I did with students in groups while working with a protractor. In my reflections, I noted how valuing students' existing knowledge underscored the congruence of my actions with my beliefs and enhanced student interest. When I

explored what students already knew about how to use a protractor, I communicated value for students' knowledge and leveraged their knowledge to inform my instructional practice. These conversations flattened the power hierarchy between student and teacher because the dialogue was equitable. The refinements I made to my ability to ask questions and paraphrase promoted a deeper understanding of the importance of students' sense of value for their knowledge. Multicultural education underscores the significance of the practices included in this intervention through its commitment to valuing the existing the knowledge of all students.

Of the curricular disciplines I thought with, CRP offered the most concrete model. CRP allowed me to ensure that my instructional practice aligned with the values of social reconstructionism and multicultural education. This model embodies teachers' moral sense of obligation to the development of students' whole selves (Ladson-Billings, 2009). The beliefs of teachers who model CRP align with practices that nurture students' intersectional identities of race and science. CRP was invaluable to the intervention design because it allowed me to put my findings and theory into concrete action. By thinking with CRP, I ensured that I incorporated the philosophy and actions of social reconstructionism and multicultural education across every social context.

The practices I included in the intervention, actively listening, paraphrasing, and asking probing questions, embodied my new understanding and value for the knowledge that students bring to the classroom. These practices reflected a hallmark of CRP wherein knowledge is considered a complex entity extracted from, rather than put into, the student (Ladson-Billings, 2009). These practices formed an intervention that allowed me to nurture the intersection of science with a student's existing racial identity. Nurturing the

intersection of race and science also nurtures a sense of wholeness, which lifts the veil that fragments the African American identity. As the veil lifts, so too does the students' sense of opportunity. This intervention emerged from the places where literature, experience, and action overlap, to inform practice and frame experiences that lift the veil.

Implications for My Practice and Other Stakeholders

Students will continue to be stakeholders in my practice because the experiences they have in my classroom contribute to their understanding of physics as a subject that restricts or broadens opportunity in science. Initially, I believed I was embracing diverse ways of engaging with science; however, as I conducted this study, it became increasingly difficult to reconcile my practice with my new knowledge. Eventually, the incongruence was so great I was forced to critically analyze and recognize how my preconscious beliefs and practices reinforced the status quo and marginalized African American students. As stakeholders in my practice, African American students will benefit from how my practice has expanded to include a range of valuable ways in which students may engage with physics. Recognizing diverse ways of learning and knowing science challenges the dominant narrative of science. The expansion of opportunity disrupts restrictive systems, and diverse learners can consider science careers that lead to economic stability (Torraco, 2018).

Recently, I began a new position as chair of the science department at my school. This new position has expanded my sphere of influence to include teachers as stakeholders and leadership as part of my practice. As a result, my school's science teachers have become stakeholders because my new, emancipatory understanding of science pedagogy influences their practice. In this expanded context that includes other

teachers as stakeholders, this study's findings will continue to challenge racial inequity in science.

As a new curriculum and pedagogical leader, the influence of my practice expands beyond my classroom to the school and includes other teachers as stakeholders. It is my responsibility to bridge state and local educational standards with my commitment to equitable education. A significant part of my commitment extends from my belief that the teacher is a continuous learner who grows through critical self-reflection and action-based research. Extending and transferring my findings and methodology to new stakeholders in the broader context of professional development is also exemplifies this study's transferability.

Transferability

In qualitative research, reliability, validity, generalizability, and transferability determine the trustworthiness of a study. Reliability is how thoroughly the study answers the research questions, while validity examines the accuracy of the answers to the research questions. Generalizability considers how the study could apply to a larger population, but transferability examines how it extends to a new context. The onus of proving the transferability of a study's findings or methodology belongs to the researcher (Herr & Anderson, 2015).

Transferability of the Findings

At first, the inimitable properties of experiential data seem to challenge how findings contribute to the understanding of a phenomenon. However, action research supports the ability of new knowledge to be transferred to new contexts even when inimitable data cannot be generalized to a larger population (Herr & Anderson, 2015).

The extensive details of narratives provide a wealth of evidence for action researchers to use when considering the transferability of findings to their context (Herr & Anderson, 2015). Despite the inimitable properties of experiential, phenomenological data, my narrative of this study's findings reinforces its transferability.

The narratives provided in this study are evidence for the transferability of these findings to new contexts where fields of power intersect. In this study, I examined how race and science in the classroom intersect and frame hierarchies of power. Therefore, individually race and science may be considered fields of power because they determine when one group is privileged and another is marginalized. It is possible to transfer the findings of this study to understand how race intersects with other content areas of limited diversity, such as math or engineering. The findings of this study are also transferable to similar problems of practice and designs for professional growth (Herr & Anderson, 2015). For example, it is not uncommon for math teachers to engage in assimilationist practices as well (Banks, 2016). Through an examination of the narratives I have included, a reader may feel the findings of this study are transferable to the professional development of math teachers. By considering the implications for the findings in broader contexts, this study adds to the literature exploring how teachers can further social justice agendas.

Transferability of the Methodology

In action research, not only are the findings transferable, the methodology may be transferable as well. Whereas the transferability of findings rests on the richness of narrative descriptions, the transferability of the methodology rests on the thoroughness of the methodological description (Herr & Anderson, 2015; Vagle, 2018; van Manen, 2014).

As I did with the findings, I have enhanced the transferability of this innovative methodology through a detailed description of the participants, context, methodology, and design of this study.

In both methodologies, experiential narratives are fragile because the researcher's perspective easily influences them. Action researchers, as well as phenomenologists, must engage in positionality and reflexivity discussions to ensure their experience does not obliterate participants' experiences with the phenomenon. By including an extensive discussion of positionality and reflexivity, I have made it easier for future researchers to maintain focus on the phenomenon.

In this study, action research and post-intentional phenomenology reinforce reflective and recursive methods. The intervention demanded by action research was put into play with critical theory by post-intentional phenomenology. The resulting critical post-intentional phenomenological action research study produced an intervention informed by experience at the intersection of social categories and fields of power. In this study, student experience and literature informed the intervention design. The recursive work throughout the intervention led to a deeper understanding of how experiences with a phenomenon, through the filter of race, could inform practice. Thus, this methodology might be transferable to research contexts that necessitate action, informed by experience, to address competing fields of power.

Herr and Anderson (2015) assert that the field of action research lacks depth concerning critical theory. While the emancipatory knowledge interest of this action research study necessitated a critical self-reflection and an intervention (Herr & Anderson, 2015), it was theory and the illumination of experience via the

counternarrative, that informed the design of the intervention. Both post-intentional phenomenology and action research's emphasis on experiential data as the source of understanding and the impetus for action allowed me to capture a wealth of data necessary for understanding how experiences at the intersection of race and science can inform practice. This blended methodology expands the field of action research by adding to the possible ways action research may engage with critical theory. Future researchers whose contexts necessitate a critical paradigm for action research should consider critical post-intentional phenomenological action research.

Further Reflections on Methodology

At the beginning of this study, I considered how the absence of female participants, the restrictive nature of my IRB, and debates surrounding phenomenological methods were limitations. Discussing them was an essential step to strengthening the trustworthiness of this action research study (Herr & Anderson, 2015). The occurrences and constraints that may have detracted from the rigor of my findings have not changed, but my understanding of them has deepened. Despite these limitations, occurrences, and constraints, future researchers should consider this methodology because it adds to the ways critical theory and experiential phenomena can inform intervention-based action. Repeated applications of this methodology could reduce the impact of these limitations.

Design Limitations

Action research provided a roadmap for me to explore how African American students experienced science and how knowledge generated from that exploration could inform my practice. Since African Americans are underrepresented in science at the national level and again in my classroom (MCPS 2019a; Torracco, 2018), understanding

their experience was essential to designing a classroom-based intervention that addressed this social inequality. Phenomenology's treatment of contextual experience as a phenomenon became critical through the consideration of race as it intersects with science. Action research, critical race theory, and phenomenology informed the design of this study, but phenomenology presented limitations.

In phenomenology, bracketing is the suspension of a researcher's beliefs so that they do not interfere with data analysis (van Manen, 2014). Researchers, including phenomenologists, are suspicious of an individual's ability to suspend their beliefs and become objective (Vagle, 2018). To address this possible limitation, I adopted a post-intentional approach. Post-intentional phenomenologists replace bracketing with bridling, which, like a horse's bridle, works continuously to control a researcher's beliefs (Vagle, 2018).

Had I not bridled my beliefs, my experiences as an African American high school science student who wished to be left alone may have eclipsed the participants' desire to be heard. Moreover, my positionality as an African American woman may have afforded a greater level of trust from the participants and may have influenced my data analysis. This shared status demanded that I acknowledge my presence in the study and include design components to address them (Herr & Anderson, 2015). Both my positionality and post-reflexion statements helped me address this bias and ensure the inferences I made from data reflect the participants' experiences and not my own.

I was able to maintain the spotlight on the participants' experiences through a post-reflexion journal and a discussion of positionality, both of which addressed my beliefs and how they came to be. Through this work, I developed an understanding of

how the inimitable individual experiences of people who share a race do not create shared beliefs. However, despite my efforts, I cannot assume that bridling, positionality, or post-reflexion removed all bias from my analysis. More importantly, the narrative discussing my methods for dealing with bias underscores the attempts I made to address researcher bias as thoroughly as possible.

Unanticipated Occurrences and Constraints

As I described in Chapter Three, the limitations imposed on my study by my school district removed the possibility of documenting current high school students' voices. This limitation could have been avoided if I had known, despite the district's regulations stating otherwise, that the district would not consider any study that occurs in the same school in which a researcher works. Unfortunately, I discovered this just before I began data collection. If I had been aware of this unwritten policy, I would have considered a different design for my study at conception.

My district's regulations for research limited the reliability of my findings to answer the research questions. Including the voice of current high school students could have provided direct insight into the experiences of African American high school students with science. Not having access to this data may have posed an unavoidable threat to the trustworthiness of this study. It is possible that the high school memories of the college students I interviewed may have faded with time. This type of threat is a subject characteristics threat, and it could have influenced both how well the data addresses the research question (reliability) and the accuracy of inferences I made via the analysis of experiential evidence (validity) (Fraenkel et al., 2015). I could have addressed this limitation by interviewing students from another school in the district; however, my

district's research regulations made this impossible as well. Another possibility would have been to interview high school students at a private school, but each school has its own policies for research, and the deadlines for submissions at the schools I investigated had passed.

A second occurrence that may have detracted from the quality of the findings originated in my sample. The design of this study included a purposeful sample of African American college students. Of the five students I invited to participate, two were male, and three were female. Unfortunately, both male students were unable to participate due to demands on their time. The resulting sample eliminated the possibility of data collection from both male and female college students. As a result, it is impossible to determine how gender may have influenced the findings of this study.

A third occurrence that must be explored further is if this study's findings are limited to science. As I explored in chapter four, in this study, I sought to identify how experiences at the intersection of race and science marginalize students. Now, I believe when restrictive practices embody science teachers' preconscious understandings of science, they frame marginalizing classroom experiences. Would it be possible to replace science with math or any other content area? My findings suggest that these findings are not limited to science but expand to encompass experiences at the intersection of race and academic identities in any classroom. Repeat applications of this study in different content areas would confirm the influence of equitable dialogue in any content area to African American students' academic identity.

Future studies should explore the experiences of male African American students with science and how an understanding of those experiences could inform science

education practices. Despite these constraints, I found a way to challenge and disrupt the norms of science education now and with future action.

Conclusions + Implications = Action

The extent to which the conclusions, implications, and action produced by this study are intertwined has made it necessary to combine them into one section. In mathematics, the Fibonacci sequence recursively demonstrates how a new number is produced by the sum of numbers that precede it. In action research, this recursive practice is demonstrated as new action is produced by the sum of the conclusions and implications that precede it. Separating the conclusions from the implications and actions would weaken my explanation of the relationship among them. To emphasize the relationship among these three components, I have put them together in this section. In the conclusions and implications subsection, I discuss the implications for the knowledge I have gained. Following this discussion, I explore the actions I will take to remain an active practitioner-researcher.

Conclusions + Implications

The experience of living as an individual of African descent in America transcends all aspects of life. No part of our lives as teachers, students, parents, and children remains untouched by the meaning of race in America. Both a teacher and a parent, Du Bois (1903) illuminated the extent of this experience when he wrote the following of his infant son's death, "Well sped, my boy, before the world had dubbed your ambition insolence, had held your ideals unattainable, and taught you to cringe and bow" (p. 111). Deep in grief, Du Bois (1903) sought solace in knowing that his son would never experience the veil. The veil, which symbolizes the divide between African

Americans' sense of self and the perceptions of African Americans by others, not only weakens African Americans' identity but also imbues social constructions of race and nationwide systems. The conclusions I have drawn from this study lead to broader implications. Despite the centrality of race and science in my study, my results suggest that pedagogy, as informed by preconscious understandings of race, is more significant to African American students' sense of opportunity than content alone. How teachers frame classroom experiences is a significant influence on the educational trajectory of African American students.

For African American children, when two discrepant sides of the veil inform their identity, they are forced to decide, throughout childhood and adolescence and into adulthood, which identity to compromise (McGee, 2013). In this study, I came to understand how a teacher's practice can lift or lower the veil, thus nurturing or undermining identity. Assigning language to a teacher's preconscious promotes an understanding of how student experience can inform their practice to include those, like equitable dialogue, that nurture students' existential sense of opportunity.

In this study, the long history of race in America, social constructions of race, and the enduring racial oppression of opportunity in science are embodied by participants' counternarratives. A cursory consideration of this new knowledge might communicate a sense of hopelessness that is best challenged with further reflection and insight. Such insight was shared in an interview by Bell (1992) with an older African American woman from Mississippi. During the interview, he asked her how, in the context of brutal oppression, she found the courage to work for civil rights. Her goal, she explained, was defiance and "at the point where she was determined to resist her oppression, she was

triumphant” (Bell, 1992, p. xii). When an individual chooses to challenge, disrupt, and resist oppression and inequity, nothing can diminish a sense of triumph (Bell, 1992; hooks, 1994).

As I consider the knowledge I have gained from this study, I comprehend how my challenging and disrupting traditional ways of teaching science and my sense of resistance to restrictions for how to conduct research became the points at which I resisted oppression and became triumphant. As the knowledge I gained from the findings and methodology of this study crystallized, I experienced empowerment and a sense of healing. Illuminating and elevating students’ voice has informed and ignited a sense of empowerment that has uplifted and motivated me to continue to disrupt and challenge inequity.

Throughout this study, I have named, wrestled, felt shamed by, and resolved to change my beliefs and practice. As an action researcher, understanding students’ experiences was essential to informing how my practice could disrupt traditional, oppressive norms of science (Efron & Ravid, 2013). The work I have engaged in has humbled me and made me a far more empathetic and effective teacher. It has also empowered me to seek opportunities beyond my classroom, where I can continue to disrupt the scientific status quo.

Action

This year I was offered the position as chair of the science department at my school. This leadership position, officially titled Science Resource Teacher, requires that I lead a department of 16 teachers and participate in the school’s Instructional Leadership Team and the district-wide science program. My new leadership position has expanded

my sphere of influence to include practitioners and policymakers at both the school and district levels. In this new position, I have the opportunity to effect change beyond my classroom.

This position gives me a voice at both the school and district levels. At my school, advanced science courses continue to reflect the underrepresentation of African American students in science at the national level. In my new and expanded context, I can work with teachers to critique their practice and transform student experiences in the classroom (Herr & Anderson, 2015). While my district's regulations for research preclude student data for graduate work, they do not prevent the use of student data to improve instruction. In my new role and with the action research purpose to advance teachers' practice and improve students' learning, I will continue to engage in interventions that broaden teachers' practice to include those that nurture students' intersectional identities (Efron & Ravid, 2013).

My new action research studies will continue to challenge inequity in education, but they will not be limited to science. As a member of our school's Instructional Leadership Team, I have input into the professional growth plans of all of the teachers in my building. In this broader context, I can advocate for the recognition of students' diverse ways of learning and knowing across content areas. To do this, I will contribute evidence and methods for nurturing the intersection of social categories and fields of power for any range of combinations. As the findings of my study regarding practice are not limited to science, I can extend them to pedagogy across content. My new position, as an instructional leader, affords influence and input into our staff's professional development.

In this position, I also have access to leadership at the district level. As I discussed previously, the rejection of my initial study resulted in a new research design. The current regulations for research, while very protective of student privacy, significantly curtail the use of action research for improving instruction across education. The intent of protecting student privacy excludes students from having a voice surrounding changes to curriculum and instruction. Using methodology and findings such as those presented in this study, I will work for curriculum change that is informed by students' voice and theory. As a leader, informed by the science office's vision for curriculum change, this would be a point of entry through which I would advocate for changes to our policies for research that respect student privacy and allow rigorous and inclusive action research. Although I cannot ignore the unjust status quo, I am fortunate to work in a district that values data-informed growth, and I look forward to exploring new paths for the expansion of opportunity.

Despite the difficulty of processing the rejection of my initial study, I was able to design a study that broadened my understanding of the world in ways I could not imagine. This study challenged my core beliefs and forced me to grow professionally and personally in unforeseen ways. One outgrowth of this study is my recognition of how action research embraces and fortifies other methodologies. By putting action research into play with post-intentional phenomenology, I have introduced action researchers as stakeholders in my research. Upon completion of this study, I intend to contribute to the action research community by writing and submitting an article on how critical post-intentional phenomenology can deepen the connection between action research and critical theory.

Figure 5.1 illustrates how my findings and action research have bridged theory with practice to raise the veil and keep it raised. My future work to address inequity in education will employ action research. As I think about the studies I will perform and the type of work I will do, I am reminded of the lines of flight. While Vagle (2018) prefers to think of them as fleeing or leaking from traditional ways of thinking, I continue to think of them like the barn swallows that execute sharp turns in an instant. As my work evolves, it will be informed by and change with shifting contexts, experiences, and my position in relation to the world (Vagle, 2018).

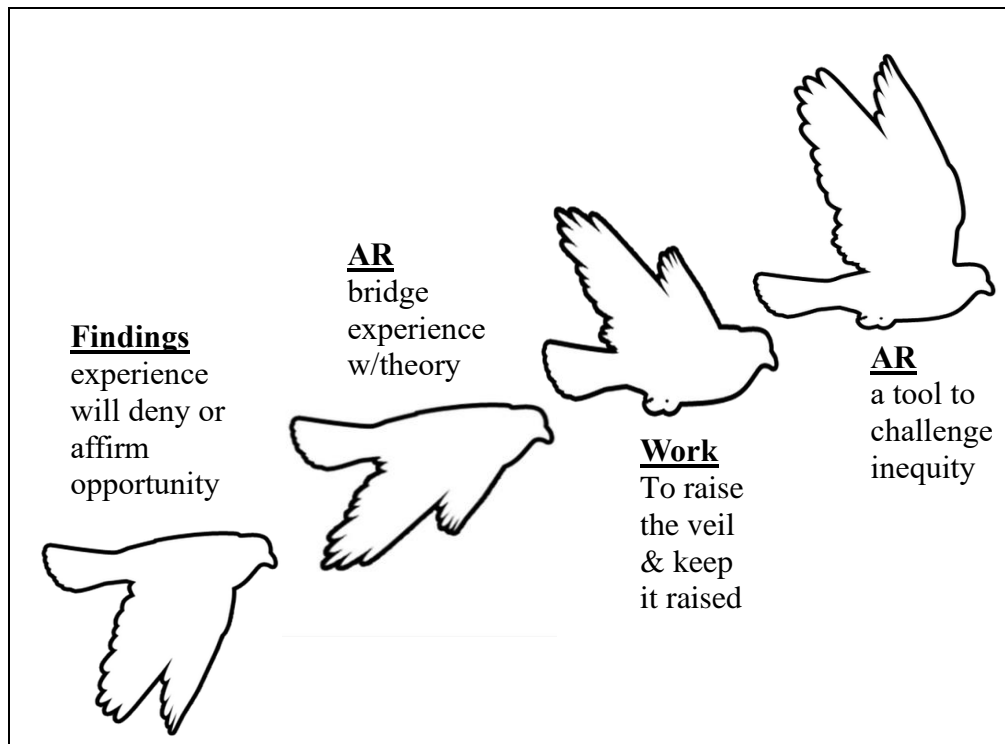


Figure 5.1 Future Action

My findings have unveiled a world in which identities intersect to deny or affirm opportunity, but I see the veil lift when experience validates a student's whole identity. As it rises, a new world evolves wherein oppressive social constructions of race weaken and diversity becomes the norm. The raised veil is a triumphant symbol of a narrative

written by African American students and not for them. As I watch the veil lift for students, I feel empowered to continue action that secures a righteous educational and economic future for African American students.

The shift in my professional perspective has been deeply personal. Each time I witnessed the renewed enthusiasm for learning in my students, my resolve to continue work toward equity in education deepens. Many years ago, I believed that in my 30th year of teaching, I would be transitioning into retirement. However, my growth has pushed me to see that my work is far from done. As I look toward my 30th year in education, I have a renewed desire to take meaningful action. Unlike the inspirational and less focused hope of my first year teaching, this new chapter is deeply informed by content and methodology for change. I accept a charge attributed to Angela Davis, “You have to act as if it were possible to radically change the world. And you have to do it all the time” (Winfrey, 2019). I can do so confidently because I have the tools to do it.

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APPENDIX A
INTERVIEW PROTOCOL

<i>Question type</i>	<i>Questions</i>
<i>Contextualization</i>	<p><i>How do you prefer to identify your race?</i></p> <p><i>Where did you go to high school?</i></p> <p><i>What science courses did you take in high school?</i></p> <p><i>What are you doing now?</i></p>
<i>How the phenomenon was lived</i>	<p><i>Walk me through your most memorable high school science classes. Try to recall and describe things you saw and felt.</i></p> <p><i>Probing questions:</i></p> <ul style="list-style-type: none"> ● <i>What did it look like?</i> ● <i>What did you notice?</i> ● <i>What did you observe?</i> ● <i>What stands out to you about the class?</i> ● <i>What stands out about the teacher to you?</i> ● <i>What was it like for you?</i> ● <i>Were you comfortable?</i> ● <i>What made you feel that way?</i> ● <i>How did that make you feel?</i> ● <i>How did that make you feel about...?</i> ● <i>What did you do?</i> ● <i>What did you say?</i> ● <i>What made you feel that way?</i> ● <i>What do you mean by...?</i>
<i>Imaginative</i>	<p><i>These questions will emerge from the participant's responses. Questions may include:</i></p> <ul style="list-style-type: none"> ● <i>Where do you see yourself in the future?</i> ● <i>How might the teacher have changed your response to the class?</i> ● <i>How do you think the teacher's actions could have changed how you experienced the class?</i>

APPENDIX B
CONSENT FORM

Dear graduate and/or parents or guardians,

My name is Gina Martin, and I am a physics teacher at [REDACTED] in Montgomery County, Maryland. I am also a doctoral candidate in the Department of Education through the University of South Carolina's online program. During the spring semester of this school year, I will be researching to fulfill the requirements for my dissertation. Through the implementation of an action research study, I will explore the experiences of African American high school graduates with high school science.

Information from this research will be used to improve my instructional practice. As a recent African American high school graduate, I am inviting you to participate in my study. Participation in this study involves a single one-on-one interview during which you will be asked questions about your experience with high school science. The interview will last no more than an hour.

With your permission, the interview will be audiotaped and transcribed so that I can capture and maintain an accurate record of your experience with science. After you have completed the interview, I will have it transcribed. Once transcribed, I will change your name. A transcript of the interview will be stored in a password-protected document in a password protected electronic database. Only I will have access to the interview data. Before the publication of my study, I will share my analysis of the data with you to ensure its accuracy. After the completion of the study, the interview data will be destroyed.

Participation in this study is voluntary, and you are free to stop participation at any time and without penalty. You may withdraw your participation verbally or in writing via any mode of communication with which you are comfortable.

If you have any questions about any part of this study or your involvement, please contact me at [REDACTED].

Thank you,

Gina Martin
Physics Teacher

Please complete, detach, and return the slip on the next page.

Graduate's name: _____

I, the graduate, consent to participating in this research study.

Graduate's Name Printed: _____ Date: _____

Graduate's Signature: _____ Date: _____

Please complete the following if the participant is a minor (under the age of 18).

_____ I give consent for my child to participate in this research study.

_____ I do NOT give consent for my child to participate in this research.

Printed Parent/Guardian Name: _____ Date: _____

Parent/Guardian Signature: _____ Date: _____

APPENDIX C

ORIGINAL OBSERVATION JOURNAL ENTRY

Activity Date: 3/9/2020	Reflection
<p>Today I</p> <ul style="list-style-type: none"> • asked students to share what they already knew about Earth science on a white board in the format of a word splash. • I used this information to introduce new ideas. Each time I put a new word up I asked students to share what it sounded like or reminded them of • Examples <ul style="list-style-type: none"> ○ Oscillation-oscillating fan that repeats a motion. ○ Propagation-many had read Animal Farm in 8th grade and were familiar with the term propaganda. • Students constructed definitions for words and we synthesized them to build understanding <ul style="list-style-type: none"> ○ Ie-many wrote that oscillation is time and we corrected it with oscillation is a motion • Students sat in groups of 4 and each time I asked someone from the group to share out it was a person in a different seat. I called on every single student who was present today. 	<p>I felt like an amazing teacher.</p> <ul style="list-style-type: none"> • Students were not on their phones or trying to sleep! • They engaged in discussion with each other and with me • They did not get off task • They debated and shared connections they had seen with the words from other places • More students than usual were excited to share • This was positive, and I was amazed at how this otherwise boring activity came alive. • Later, when I went next door to spy on the other teacher who was teaching my lesson there were engaged 12th graders his class is usually silent and does not interact but there was laughing and talking. Discussion with the teacher and he tied together their ideas (as I did) into definitions. • I was amazed. Instead of not talking, the student was fully engaged in class today and was in his group's discussions. Is it really this simple? To see some one?

Narrative:

In the past I've given this information to students as notes. Today's change in practice emphasized structured student discourse with room for students to add in personal knowledge. Clearly I haven't done this in the past because some kids thought their ideas were stupid. I recall that I circled back and instead of saying "your ideas aren't stupid" I asked the kid more questions about what it reminded them of and listened-trying to show that actions speak louder than words. It was interesting to hear students use the words from the prior round to explain words in the new round-I could see that the definitions they constructed made much more sense. I have this developing awareness of how when I teach these as notes, I am communicating an assumption that students know nothing and that I need to bank information in their brains. Instead I think this lesson did more to extract knowledge from students—just like the CRP model asserts is important.