Supporting Black Students in Sixth-Grade Science Through a Social Constructivist Approach: A Mixed-Methods Action Research Study

Kirk Anthony Heath

Follow this and additional works at: https://scholarcommons.sc.edu/etd

Recommended Citation

This Open Access Dissertation is brought to you by Scholar Commons. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of Scholar Commons. For more information, please contact digres@mailbox.sc.edu.
SUPPORTING BLACK STUDENTS IN SIXTH-GRADE SCIENCE THROUGH A SOCIAL CONSTRUCTIVIST APPROACH: A MIXED-METHODS ACTION RESEARCH STUDY

by

Kirk Anthony Heath

Bachelor of Technology
Nova Scotia Agricultural College, 2004

Master of Arts in Teaching
Mico University College, 2013

Submitted in Partial Fulfillment of the Requirements
For the Degree of Doctor of Education in
Educational Practice and Innovation
College of Education
University of South Carolina
2023

Accepted by:
Elizabeth Curri, Major Professor
Becky Morgan, Committee Member
Todd Lilly, Committee Member
Brooks Rosenquist, Committee Member
Ann Vail, Dean of the Graduate School
DEDICATION

I dedicate this academic work to my wonderful family who supported me throughout my dissertation process. This journey was easier because you believed in me.

Thank you.
ACKNOWLEDGEMENTS

My first thanks go to the highest, God, who strengthens and encourages me to be steadfast. This journey was challenging but surmountable due to the support of my fantastic wife, Kenesha, and children, Kaheem and Kaci. You are my life partners who stayed and inspired me continually. Special thanks to my principal and school district for promptly approving my study. Thanks to my coworkers who provided continued moral and academic advice that kept me motivated; you have been a beneficial human resource. My science team leads, Ellie and science department members Max and Brian, I value your continued encouragement and resourcefulness. Finally, I want to recognize my dissertation chair, Dr. Elizabeth Currin, for being astute and ethical in guiding me to complete this discourse; thank you.
ABSTRACT

The purpose of this mixed-method action research study was to improve Black students’ performance in my sixth-grade science class by improving their ability to use the claim, evidence, and reasoning (CER) framework. Using criterion-based convenient sampling, I enlisted 17 Black participants, all of whom were underperforming in my science class at a suburban, middle-class, predominantly White public middle school serving Grades 6–8. As a teacher researcher, I implemented and assessed an intervention designed to improve their ability to use the CER framework. Using a mixed-method action research design, I simultaneously collected and triangulated quantitative and qualitative data.

This study may inform future studies or provide insights into solving similar problems at my middle school or other schools in the district. Teaching CER skills to Black students to improve their science performance allowed me to improve my pedagogy through this action research cycle. I gained new knowledge to apply to my immediate teaching and learning process in my classroom or science department. My colleagues can also benefit from my findings and use them to support their teaching.
# TABLE OF CONTENTS

Dedication......................................................................................................................... iii
Acknowledgements........................................................................................................... iv
Abstract............................................................................................................................. v
List of Tables ...................................................................................................................... vii
List of Figures ................................................................................................................... viii
List of Abbreviations ......................................................................................................... ix
Chapter 1: Introduction ...................................................................................................... 1
Chapter 2: Literature Review ............................................................................................. 16
Chapter 3: Methodology .................................................................................................... 36
Chapter 4: Findings ........................................................................................................... 55
Chapter 5: Implications ..................................................................................................... 87
References .......................................................................................................................... 97
Appendix A: Parental Permission Form ............................................................................. 110
Appendix B: Pre- and Post-intervention Test 1 and 2 ...................................................... 114
Appendix C: Survey Questions .......................................................................................... 121
Appendix D: Observation Journal and Checklist ............................................................... 122
LIST OF TABLES

Table 3.1 Research Timetable.................................................................40
Table 3.2 Example of Student Observations............................................47
Table 4.1 Initial Codes............................................................................57
Table 4.2 Grouping Initial Codes Into Preliminary Themes.......................58
Table 4.3 Finalizing Themes.................................................................60
Table 4.4 Grading Scale for Pre- and Posttests........................................79
Table 4.5 Unit 1 Results.........................................................................79
Table 4.6 Unit 1 Descriptive Statistics ......................................................80
Table 4.7 Unit 2 Results.........................................................................80
Table 4.8 Unit 2 Descriptive Statistics ......................................................81
Table 4.9 Survey Descriptive Statistics .....................................................81
Table 4.10 Skewness and Kurtosis Values ................................................82
Table 4.11 Paired Samples Test for Research Question 1.........................83
Table 4.12 Paired Samples Test for Research Question 2.........................84
LIST OF FIGURES

Figure 2.1 Fishbone Diagram .................................................................17

Figure 2.2 ZPD as a Critical Component of Social Constructivism .....................24

Figure 2.3 A Social Constructivist Approach to Teaching and Learning .................25

Figure 2.4 SDT and Students’ Science Performance .........................................27

Figure 2.5 GRR Model ..............................................................................30

Figure 3.1 Research Questions vs. Data Collection Tools ....................................41

Figure 3.2 Visual Aid From Introductory Lesson ..............................................43

Figure 3.3 Student Work Sample ..................................................................44

Figure 3.4 Samples of Student Work .............................................................45

Figure 3.5 Models Created by Students ........................................................46

Figure 3.6 Experimental Setup .....................................................................47

Figure 3.7 Six-step Model for Thematic Analysis of Qualitative Data ..................51

Figure 4.1 Histogram of Difference Scores ....................................................82

Figure 4.2 Difference Scores for the Importance of Learning CER as a Black Student .............................................................................83
LIST OF ABBREVIATIONS

CER.................................................................................................................. claim, evidence, and reasoning
ELA.................................................................................................................... English Language Arts
GRR ...................................................................................................................... gradual release of responsibility
SDT..................................................................................................................... self-determination theory
SLO..................................................................................................................... student learning objective
ZPD..................................................................................................................... zone of proximal development
CHAPTER 1

INTRODUCTION

After graduating from college over 20 years ago, I developed a passion for teaching science at the middle and high school levels, which I have done at multiple schools across the United States. Throughout this time, I have endeavored to develop students’ scientific literacy and science process skills through hands-on experience. I currently work in a suburban, middle-class, predominantly White middle school in the western United States, where I noticed my Black students consistently scored poorly on their internal and external exams, classwork, tests, and quizzes.

Although White students may also struggle to perform in school, research has established pronounced levels of underperformance among Black students related to marginalization. For example, Billingsley and Hurd (2019) investigated the role of discrimination and mental health in the academic performance of underrepresented Black college students. From a sample of 340 students, the results indicated depressive symptoms due to continued discrimination contributed to lower GPA scores. Edwards (2020) reported similar results when investigating the academic challenges experienced by young, Black students affected by homelessness, who had trouble accessing academic and social support. Likewise, Al-Tameemi et al. (2023) emphasized the inaccessibility of academic resources and a lack of social and academic support as explanatory factors for negative academic outcomes. In other words, the problem is not the students but the social conditions these scholars have identified, so I needed to adjust my approach.
Because I aspire to be an agent of change, I resolved to take pedagogical action to improve these students’ science performance. Krishnan (2007) described a change agent as “someone who identifies a need for change, envisages a better future based on the change, inspires people to walk with the change, and finally makes change a way of life” (p. 49). Because my Black students had been performing below their peers for several years, I had an ethical responsibility to change my approach in hopes of ensuring their success in sixth-grade science.

My school uses a claim, evidence, and reasoning (CER) framework for argumentative writing across all subjects, so the same standard for English Language Arts (ELA) applies in science courses as well. Based on ELA trend data from the student learning objective (SLO) assessment of Grade 6 argumentative writing, of my 17 Black students at the time of this study, nine (52.9%) were either significantly underprepared or underprepared, two (11.8%) were somewhat prepared, three (17.65%) were prepared, and three (17.65%) could not be quantified. The ELA Grade 6 argumentative writing curriculum scaffolds students’ use of the cross-curricular CER framework, suggesting more than half of my Black students could not effectively write a CER response to a question. These skills are integral to students’ success in my classroom and throughout middle school. Therefore, I hypothesized that mastering the use of CER skills would help students overcome their academic underperformance.

Reinforcing the need to enhance Black students’ performance and academic preparedness in schools, my district has a Black Excellence Resolution, emphasizing “our commitment to justice and support for our Black and African American students” (Denver Public Schools, 2020, p. 2). In other words, the problem with Black students’
underperformance went beyond my school: it was a district-wide concern. As a Black parent of two Black children who are also students in the district, I felt compelled to improve my Black students’ ability to use CER skills to increase their academic performance in science. Based on my school’s Grade 6–8 science argumentative writing objectives, all students should be able to use CER skills to write an argument and rebuttal when engaging in investigations focusing on the science standards within each unit of study. When my Black students were not demonstrating these competencies, as an aspiring change agent, I wanted to give them an equitable chance of succeeding.

**Problem of Practice**

The problem of practice for this action research study was Black students’ underperformance in my science classes. This problem goes beyond my school or district. According to the National Center for Education Statistics, “the average science scores for White fourth- and 8th-grade students remained higher than those of their Black and Hispanic peers in 2015,” even though “racial/ethnic achievement gaps in 2015 were smaller than in 2009” (Hussar et al., 2020, p. 94). Among 12th-grade students, “racial/ethnic achievement gaps did not measurably change between 2009 and 2015” (Hussar et al., 2020, p. 94). If Black students continue to lag behind other racial groups in their science performance, the problem of their underperformance worsens.

As a middle school science teacher, I am responsible for providing an equitable and inclusive learning environment for all science students—especially Black students. Extant literature offers some explanations for their unpreparedness or under-preparedness that could inform my actions as a practitioner. For example, just as Edwards (2020) cited inaccessible academic support and lack of resources as contributors to poor academic
outcomes, Jackman and Morrain-Webb (2019) found that a lack of support from parents, teachers, and peers affected the morale and preparation of student participants. Likewise, Sewell and Goings (2020) demonstrated that lack of or limited representation at the faculty level limited the amount of support and guidance available to Black students.

Merolla and Jackson (2019) attributed the widening academic achievement gap in the United States to a combination of structural racism, prejudice, and bias. Similarly, Lucey and Saguil (2020) argued that structural racism may segregate Black students and alienate them from activities that would prepare them academically. For example, structural racism denies Black students the academic support needed to prepare them for exams and random tests to gauge their performance and academic readiness.

Although my study did not measure these specific factors, having them in mind and understanding how they influence the preparation and academic performance of Black students shaped my introduction of the CER framework as a means of helping students succeed. In other words, given the academic and equity challenges facing Black students compared to their counterparts, I wanted to promote social justice through education to improve their science performance, specifically by improving their ability to use the CER framework.

Among other research related to Black students’ racial disparities in science, London et al. (2021) explored Black children’s access to and experiences with STEM. They found that SES, policy, approaches to STEM education, and local context have contributed to a gap in Black students’ representation in engineering. As a result, the researchers emphasized the need for STEM education that “resonate[s] with Black children on a cultural level, and account[s] for ways in which racism, sexism, and
classism may significantly impede the educational opportunities of children in certain communities” (London et al., 2021, p. 1015).

In another study, Sheth (2019) used a qualitative inquiry backed by critical race theory and sociopolitical perspectives on teaching and learning to explore science teachers’ impact on students of color, in search of “a race-conscious solution” to the problem of “unequal power relations” (p. 38). Critiquing the teachers’ failure to attract students’ interests, Sheth (2019) recommended “‘grappling with racism’ needs to be taught during science teacher certification programs” (p. 54) and reiterated in context-specific professional development. Sheth’s study gave me added perspective on my problem of practice. I needed to be more aware of racism and marginalization and develop more culturally relevant lessons to support my underperforming Black students.

As I strove to improve my Black students’ performance, Vakil and Ayers (2019) also shed light on how to approach my study, as they sought to “examine current realities of, and boldly imagine future possibilities for, STEM education in the lives of racially minoritized children in the United States” (para. 1). They suggested STEM learning requires careful monitoring of “the quality of student relationships” (Vakil & Ayers, 2019, p. 456), given how socioeconomic differences contribute to inequitable interactions at school. Therefore, I identified a theoretical framework to support my efforts to promote more equitable relationships among students and with science content.

**Theoretical Framework**

A theoretical framework “is the underlying structure, the scaffolding or frame of one’s study. It is derived from the orientation or stance one brings” (Merriam & Tisdell, 2016, p. 85). This stance, which Grant and Osanloo (2014) described as a “world view or
lens,” supports both the researcher’s “thinking on the problem and analysis of data” (p. 15). For my study, I used principles of social constructivism, self-determination theory (SDT), and the gradual release of responsibility (GRR) framework to attempt to resolve my problem of practice and eventually make sense of my findings.

**Social Constructivism**

My action research occurred in my classroom with a specific group of students with unique characteristics related to the problem of practice. My Black students come from diverse socioeconomic backgrounds and have different learning abilities, disabilities, and styles. As Bruner (1960) stated, “each generation gives new form to the aspirations that shape education in its time” (p. 1), which resonated with how I viewed my Black students and their unique challenges with underperformance in science—a situation happening in a time and place that impacted my students’ education. My problem of practice, Black students’ underperformance in my science classes compared to other racial groups, especially Whites, called for a constructivist approach to teaching and learning. According to Cooperstein and Kocevar-Weidinger (2004), “In typical constructivist sessions, as students work on a problem, the instructor intervenes only as required to guide students in the appropriate direction. Essentially, the instructor presents the problem and lets the students go” (p. 142). Without CER skills, my Black students struggled to scaffold their learning. Therefore, improving their performance required a social constructivist approach to my science lessons in which students can have more collaboration through voice, choice, and hands-on activities.

In a subfield of constructivism, “social constructivists maintain that we invent the properties of our world rather than discover them” (Kukla, 2000, para. 1), emphasizing
how that process occurs in community. Specifically, social constructivists believe that “social interaction with more knowledgeable others” is critical to help students “internalize and understand” their learning (Pritchard & Woollard, 2010, p. 6). Chapter 2 expounds on how social constructivist thinking informed my action research.

In addition to situating this study in social constructivism, I adopted a transformative worldview to address the problem, purpose, and methodology. According to Creswell and Creswell (2018), “social constructivists believe that individuals seek understanding of the world in which they live and work” (p. 7), while transformative researchers focus on helping the “marginalized or disenfranchised” (p. 10). Through this study, I sought to help my Black students who were marginalized by their underperformance in science compared to their peers.

**Self-Determination**

Achieving the transformation I sought required student buy-in, too, so I turned to SDT, “a macro theory in human motivation” (Keshtidar & Behzadnia, 2017, p. 2) that describes the construct as a continuum. Through the lens of SDT, my Black students seemed demotivated and frustrated when they could not effectively state a scientific claim, cite evidence to support it, and provide reasons. This problem was particular to my Black students because they were performing below their peers daily. Other racial groups did not exhibit such consistent underperformance. My Black students’ location at one end of the motivation continuum could reflect poor preparation in the early stages of their learning due to inadequate support, if not structural racism (Edwards, 2020; Merolla & Jackson, 2019; Sewell & Goings, 2020). Though other marginalized communities, such as Hispanic and Asian students, also experience underrepresentation and discrimination
that can impact their performance, academic inequality associated with structural racism, bias, and prejudice is especially pronounced among Black students (Loeb & Hurd, 2019; Thiem & Dasgupta, 2022), hence the focus of my research. I needed to foster students’ self-determination to improve their science performance. Therefore, SDT provided a secondary lens through which I designed, implemented, and evaluated my intervention.

**Gradual Release Model**

To move my students along the continuum toward self-determination, I implemented practices conducive to gradually releasing my responsibility for instruction. Fisher and Frey (2013) developed the GRR framework to describe how students gain knowledge over time as they toggle between being dependent and independent learners. In my experience, students are more likely to take ownership of their learning when they acquire sufficient knowledge and skills, but when instruction “shifts from teaching (the teacher’s stance) to learning (the student’s stance)” (Frey & Fisher, 2013, p. 2), students begin to think and work previously done by the teacher.

**Purpose and Research Questions**

Through mixed-method action research, I aimed to improve Black students’ performance in my science classes. I used the SLO ELA Grade 6 argumentative writing report on recommended preparedness to obtain pre-intervention quantitative data on Black students’ ability to use CER skills. I compared those results to post-intervention quantitative data and explored the outcomes in more depth through qualitative analysis.

Chapter 2 elaborates on how existing literature and my theoretical framework informed the design of my intervention. Briefly, I recognized the need to provide adequate support to equip Black students with science learning skills and enhance their
ability to collaborate and engage with the content, their peers, and me. The CER framework can be daunting for sixth-grade students with limited science knowledge. Consequently, I had to set up structures from a social constructivist lens that allowed students to become independent learners. Scaffolding, demonstrating, and providing sentence stems was critical, especially for students with low reading levels. For example, because some students struggled to formulate sentences, my social constructivist perspective prompted me to consider other ways for them to participate and demonstrate their thinking. I gave students the autonomy to work with peers or groups as I took a more passive role, honoring students’ voice and choice. Additionally, although I enforced safety guidelines, students were responsible for setting up their science experiments or constructing their models. In other words, I designed the classroom environment as a democratic, safe space in which there is value and mutual respect.

An overarching research question guided my study of the impact of these changes: What happens when I take a more social constructivist approach in my classroom? More specifically, I collected data to answer the following questions:

1. How does adapting my approach impact my Black students’ grades?
2. How does adapting my approach impact my Black students’ attitudes?
3. How does adapting my approach impact my Black students’ behavior?

With my belief that every child can learn, given the appropriate academic support, these questions reflect my intention to adopt a social constructivist approach—and my emphasis on equity, given that students could actively participate in my study (Nogueira, 2019). My role as an action researcher was to find ways to stem or reduce the problem that hampered my Black students’ performance in science (i.e., to provide the appropriate
academic support that would increase their self-determination), which I attempted through a social constructivist approach backed by the GRR framework. With this structure, students can experience a democratic classroom that facilitates collaboration and hands-on work through student agency. Such support may motivate students as they move from dependent to independent learning.

While the first question explicitly addresses the initial problem of practice, the other questions acknowledge that performance goes beyond grades. For example, students’ negative attitudes toward science or absenteeism could play a role. Moreover, disproportionate levels of poverty because of structural racism, according to Edwards (2020), can manifest in an inferiority syndrome that causes Black students to disengage. I have also seen evidence of disengagement in terms of students’ behavior in science class.

Wolf et al. (2020) defined attitudes as “summary evaluations of people, groups, ideas, and other objects, reflecting whether individuals like or dislike them” (para. 1). Some of the attitudes my Black students displayed in science class include reluctance toward starting and completing a task, claiming to feel tired or sick, being late for class, or complaining about not liking or wanting to begin an assignment. Because attitudes are critical for understanding how individuals view the world and behave (Wolf et al., 2020), my Black students’ attitudes toward science had implications for their behavior, which was more observable. In my classroom, I had observed disruptive behaviors such as yelling profanity; saying “I do not know” or “I cannot do it;” walking out of class without my permission; slamming doors and desks; and throwing objects like pencils, Chromebooks, and binders on the floor.
I reasoned that improving Black students’ performance required first changing their attitude toward science by equipping them with skills to identify a scientific claim, support it with evidence, and provide a valid justification. Further, to adopt a student-centered and social constructivist approach (Schiro, 2013), I sought to encourage my Black students to apply their critical thinking skills to science and interact with high-scoring peers during class and in their free time. As I partnered with my Black students in practicing CER skills to improve their performance, my intervention had both social and academic benefits.

My questions facilitated “the integration of qualitative and quantitative data,” which “yields additional insight beyond the information provided by either the quantitative or qualitative data alone” (Creswell & Creswell, 2018, p. 4). Through mixed methods, I investigated my students’ perspectives and my observations as a teacher alongside performance data. Doing so illuminated why Black students were underperforming in my science classes and whether adapting my approach to teaching CER skills improved their science performance.

**Positionality**

As the practitioner in this study, I was an insider working with other insiders (i.e., my sixth-grade science students), which provided “a way to do research that not only might have a greater impact on the setting but also has the potential to be more democratic” (Herr & Anderson, 2015, p. 45). My students had a voice or opportunity to express themselves both orally and in writing. This benefit was especially evident in the qualitative aspect of my study as I sought to understand my Black students’ views of their underperformance in my science classes. Merriam and Tisdell (2016) stated that action
research “not only seeks to understand how participants make meaning or interpret a particular phenomenon or problem in their workplace, community, or practice, but it also seeks to engage participants at some level” (p. 49).

Despite the benefits of an insider approach, because my action research occurred in my immediate classroom space with my students, I prioritized ethicality throughout the institutional review process. Peltokorpi et al. (2012) posited, “Conducting research in the classroom among children is challenging but also of primary importance” (p. 33). As Chapter 3 explains, I ensured parents and guardians approved of students’ participation and communicated with them my intention to use pseudonyms to protect participants’ confidentiality and use secure data collection and storage procedures. I also demonstrated respect for the research site by balancing my research needs and priorities with my responsibilities as a teacher (Efron & Ravid, 2013).

My research centered on Black students’ underperformance in my science classes. Depending on one’s perspective, race may “bring out sensitive or labeling information” (Peltokorpi et al., 2012, p. 34). Peltokorpi et al. (2012) also warned that “When the research theme is very sensitive, plenty of obstacles to participation will occur” (p. 34). Although I struggled to recruit and retain participants and ran the risk of not being able to carry out the research, I had enough participants and opportunity to support my students (Peltokorpi et al., 2012, p. 34). Specifically, as the authority figure in the classroom, I needed to ensure my students were comfortable during the research process and that their participation was voluntary.

However, as a Black science teacher who researched my own Black students, I was aware my own racial identity may cause parental guardians to be more open to give
permission for their child to participate in my study. As a successful Black science teacher, I am living proof that my Black students can succeed in science. On the other hand, if I were a White teacher, students may participate more freely due to the dominant culture of White supremacy. Based on my experience, students were more likely to obey and support White teachers. Regardless of how my positionality influenced the study, although I was unable to eliminate all bias, I endeavored to be transparent to ensure the integrity, validity, and reliability of my research. Above all, I did not place my participants in harm’s way (Efron & Ravid, 2013).

**Research Design**

As I indicated, my mixed-methods action research study incorporated an intervention designed to improve Black students’ ability to use CER skills, which, in turn, could improve their performance in science. As a classroom teacher, I intended to address a problem in my sixth-grade science classes, through action research, which is “constructivist, situational, practical, systematic, and cyclical” (Efron & Ravid, 2013, p. 7), and consists of “generating, implementing, and assessing an action plan” (Osterman et al., 2014, p. 86). I identified a problem, gathered background information, and designed the study. I then collected, analyzed, and interpreted data; shared my findings; and reflected on the problem again (Efron & Ravid, 2013). As expected, this process was “much more dynamic, fluid, and, at times, messier” than this dissertation might imply (Efron & Ravid, 2013, p. 8). I attempted to be as systematic as possible in my design, which benefited doubly from the use of qualitative and quantitative data.

Specifically, I used a convergent strategy to collect quantitative and qualitative data concurrently, which facilitated holistic analysis (Creswell & Creswell, 2018). The
SLO based on ELA Grade 6 argumentative writing served as quantitative data for an initial baseline, along with a content-based baseline assessment. Averaging the scores suggested students’ overall preparedness prior to the intervention. I supplemented these measures with qualitative data obtained through pre-intervention surveys and repeated the initial measures in a follow-up phase after adapting my instructional approach. During the intervention, I collected qualitative data through surveys and observation. Chapter 3 elaborates on the distinct methods I used for qualitative and quantitative data analysis (Braun & Clarke, 2006; Creswell & Creswell, 2018; Efron & Ravid, 2013).

Chapter 3 also elaborates on my efforts to ensure the credibility and accuracy of my findings (Creswell & Creswell, 2018). According to Efron and Ravid (2013), “the trustworthiness and validity of qualitative and quantitative approaches are different” and thus require different strategies (p. 73). I especially strove for internal validity, which “refers to any relationship observed between one or more variables” (Fraenkel et al. 2015, p. 167), and content-related validity, which occurs when “the content and format [are] consistent with the definition of the variable and the sample” (p. 152). As Chapter 3 illustrates, my understanding of these two types of validity added credibility to my mixed-method study. I recognized that a high-quality study is more likely to achieve the desired outcome.

**Significance**

One of the benefits of this study is that it may provide ideas for future studies or insights into solving similar problems at my middle school or other schools in the district. Efron and Ravid (2013) shared, “action researchers study their work, and the study’s findings contribute directly and immediately to their practices” (p. 49). However, action
research can resonate beyond the study site. By attempting to improve my own pedagogy through this action research cycle, I anticipated gaining new knowledge that I could apply immediately in my classroom or science department. My colleagues have already benefited from aspects of my findings and are using them to support their own teaching. Although my study was not generalizable and may be limited by my own biases, Chapter 5 reveals how inviting my Black students to share their views about how the CER framework impacts their science performance has significant and transformative implications, consistent with my desire to be an agent of change.

**Key Terms**

*Black or African American*: “A person having origins in any of the Black racial groups of Africa” (Hussar et al., 2020, p. 315).

*Gradual Release of Responsibility*: “A systematic approach for shifting the cognitive work from teacher to learner is in order. This shift requires a gradual release of cognitive responsibility across every lesson” (Fisher & Frey, 2013, p. 2).

*Performance*: A student’s ability to demonstrate mastery of a task.

*Science*: A body of knowledge, skills, and attitudes that helps individuals to understand, appreciate, and make use of their environment to satisfy needs and wants.

*Self-Determination Theory*: “a macro theory in human motivation and personality that emphasizes the influence of social context” (Keshtidar & Behzadnia, 2017, p. 2).

*Social Constructivism*: “A theory that emphasizes the role of others and all forms of social interaction in the process of constructing knowledge and understanding” (Pritchard & Woollard, 2010, p. 6).
CHAPTER 2

LITERATURE REVIEW

A literature review encompasses the foundation and scholarship to support a study. Accordingly, Machi and McEvoy (2016) stated, “A literature review synthesizes current knowledge about the research question . . . through logical argumentation” (p. 1). Chapter 1 introduced the problem of practice for this action research study: Black students were underperforming in my science classes. Viewing this challenge as an equity issue, I wanted to promote social justice by improving my Black students’ science performance, specifically by adapting my approach to introducing and facilitating their use of the CER framework. As agents of change, teachers like me can strive to provide adequate support to traditionally underprivileged students (Gershenson et al., 2015). Reviewing scholarship related to my problem prepared me for this aim.

**Contributing Factors**

Improving Black students’ science performance requires effective science teaching, which warrants consideration of the educational challenges Black students face. Articles that highlighted factors contributing to students’ underperformance in science in general (Banerjee, 2016; Mji & Makgato, 2006) positioned me to wonder about underlying causes of my Black students’ underperformance, contemplate why my existing approach was not working, and consider how I could adapt my approach toward resolving the problem of practice. The fishbone diagram in Figure 2.1 illustrates my effort to visualize and organize the root causes I identified across existing scholarship:
low SES, the need to nurture students of color, racial disparities, the need for parental support, the need for Black role models, and attendance concerns.

Figure 2.1 *Fishbone Diagram*

**SES**

A student’s elementary SES composition has a legacy effect on middle school achievement (Langenkamp & Carbonaro, 2018). Moreover, Dotson and Foley (2016) shared, “In every state in the nation, the economically disadvantaged subgroup never outperforms other non-labeled students regardless of the grade level or subject area, supporting that the variable with the strongest correlation to academic achievement is socioeconomic status” (p. 34). Research indicates the probability of educational failure for students living in poverty is a multifaceted, challenging, and persistent global problem, and the complexity of students’ poverty has implications beyond the scope of schools (Graham et al., 2019). According to Dike (2017), poverty contributes to students’ brain development, making learning more difficult in the 21st century. Similarly, Pearman (2019) reiterated that students exposed to poverty-stricken neighborhoods show
a depressive academic growth and a treatment effect almost equivalent to missing three-quarters of a year of schooling over a 5-year treatment period. Despite the socioeconomic challenges facing some of my Black students, which are beyond my control, I must ensure their success in science.

**Nurturing Students of Color**

In addition to devoting special attention to the impact of SES, educators need to be intentional in their efforts to nurture students of color. In fact, Molina et al. (2016) argued that “engaging poor children of color” necessitates using “education as a tool of liberation” (p. 21). To that end, Mize and Glover (2021) called for curriculum reframing to improve Black students’ academic performance through instructional equity. In the context of this study, curriculum reframing is a term that describes any modification to the lesson that provides equitable opportunities to improve students’ learning. For example, I chose to adapt my instruction through a social constructivist lens, giving students democracy through voice, choice, hands-on activities, and collaboration. Employing Molina et al.’s. (2016) idea of education as a tool for liberation, I sought for my Black students to access education in a more meaningful manner, relating to the instruction as they developed their knowledge and skills. Black students in my classes needed this kind of equitable support, which demands an understanding of racism as a systemic, recurring problem (Willison, 2016).

Noting that people of color are leaving STEM fields, Molina et al. (2016) suggested such targeted support is especially vital in STEM education for the United States to maintain a global competitive edge. Similarly, Phillips (2022) expressed concern for Black female students’ underrepresentation in STEM careers, citing the
impact of microaggressions, inequitable funding, and negative perceptions. Ensuring students can succeed in academic subjects may involve nurturing their mental, social, economic, and physical well-being. Ajijola et al. (2022) also acknowledged Black underrepresentation in STEM, emphasizing the need for adequate funding, as well as mentors and role models—other components of my fishbone diagram.

To address such barriers to Black students’ success, Brown (2021) called for “transforming . . . schools into places that cultivate bold, brilliant, and fearless Black students” (p. 89). Brown’s argument for supporting, developing, and motivating Black students aligned with my aim to improve students’ science performance, attitude, and behavior. To provide Black students with the equitable opportunity they deserve, my intervention, grounded in my theoretical framework, needed to create a student-friendly learning environment that inspires success.

**Racial Disparity**

According to Mickelson (2003), racial and ethnic educational disparities are standard in U.S. schools, rooted in Jim Crow discrimination. In response to racial disparities in science fields, Visintainer (2020) studied how high school students of color make sense of the racialized narratives about science that circulate in society and how these storylines shape their positioning and identity construction in science. Because such narratives harm students of color and how they view themselves in the science education community, Visintainer (2020) argued they “must be disrupted and dismantled” (p. 6). This type of racial disparity was evident in my classroom in subtle ways, reflected in my Black students’ negative attitude toward science classes and careers and their underperformance in science subjects.
Titu et al. (2018) shared another perspective on racial disparity by exploring how a 4-week course on equitable science teaching influenced the attitudes of beginning secondary science teachers toward teaching culturally diverse students. Findings suggest the course positively impacted the new teachers’ attitudes and behavior toward culturally diverse students. Adopting a similar stance could positively impact my Black science students’ interest and performance in science. With my years of experience teaching science to middle and high school marginalized students, I could employ more equitable and innovative teaching strategies to improve my students’ science performance.

**Parental Support**

Teachers are not the only adults who play an important role in students’ lives. Marcucci (2020) examined how parental involvement affects racial disparities in disciplinary outcomes in in-school suspension and explained, “Low-income, African American parents are marginalized simply because they do not have access to the capital that society has deemed dominant” (p. 161). Such inequities may impact students’ performance in my classes. Marcucci encouraged an asset view and recommended partnering with parental figures to maximize resources for more equitable learning. However, in another study on parental involvement, Leath et al. (2020) noted that “for Black parents, cultivating positive interactions with school personnel and forming a foundation of trust may be complicated by the history of academic and social marginalization of racial/ethnic minority students in U.S. schools” (p. 133).

Fortunately, Leath et al. (2020) also shared that “some mothers intentionally sought out same-race teachers” in their efforts “to advocate and intervene” for their children (p. 133). As a Black parent and science teacher, I could grant students access to
more capital at school and in society, making them more likely to succeed. Further, by notifying students’ guardians about my study, I could sensitize them to the problem of Black students’ underperformance in science and my intention to adapt my pedagogical approach, in line with my research questions.

**Black Science Teachers as Role Models**

As Leath et al. (2020) indicated, some parents prefer their children to have same-race teachers. My Black students’ parental guardians could appreciate that I, as a Black teacher, wanted to give their child more equitable learning opportunities. Other students may not have that opportunity due to Black teacher attrition, which Mensah (2009) lamented because when teachers of Black students emphasize “understanding science, thinking critically about science and the world, and being prepared for the future science careers in a postmodern world,” they can empower students “to see science as connected to their daily lives” (p. 48). For example, Milner (2016) highlighted a Black math and science teacher’s use of culturally responsive pedagogy to validate middle school students as part of the learning process. By demonstrating affirmation, the teacher simultaneously respected and learned from students. However, Milner (2016) cautioned that such practices require educators to be “comfortable with their own identities and worldviews which may be consistent or inconsistent with those of their students” (p. 48). Therefore, Black science teachers like me can add value to students’ lives and community in that my job status provides Black students with a visible example of a successful person of color, suggesting they, too, can succeed.

In another study on Black educators, and more specifically, science teacher preparation, Atwater et al. (2013) emphasized how “ethical, political, and cultural issues
in science classrooms are very complex” (p. 1309) and suggested a diverse teaching staff is more likely to promote equitable science teaching in K–12 schools. However, the Black science educators in the study experienced exclusion and oppression, highlighting an urgent need for Black science educators to be a more integral and valued part of a school climate. These findings prompted me to consider the positive ripple effect I could have as a Black science teacher with an equitable and inclusive approach to teaching science, especially if my action research succeeded.

**Attendance**

In my science classroom, attendance was another factor impacting Black students’ performance. Lasky-Fink et al. (2020) studied behavioral insights and randomized experiments for improving administrative communication as a means of improving students’ attendance rates. They found, “The most effective modified notices used 60% fewer words than the Standard Notice, highlighted parents’ role in reducing student absences, and reminded parents that absences can add up to have negative consequences on academic performance” (Lasky-Fink et al., 2020, p. 448). Such efforts reduced truancy in a month by 2% and increased parental support. Earlier, Davis and Jordan (1994) studied the effects of school context, structure, and experiences on African American males in middle and high school and found that suspension and remediation reduce student engagement and achievement, in addition to yielding negative behavioral outcomes. Knowing attendance could affect my ability to teach students to use CER skills effectively, this existing research gave me strategies to overcome potential obstacles. Although my study did not directly address attendance, the components of the fishbone diagram expanded my understanding of my problem of practice.
Theoretical Framework

In addition to reviewing literature related to the root causes of my problem of practice, I also extended my understanding of the theoretical framework I introduced in Chapter 1, especially given the central question of my study: What happens when I take a more social constructivist approach in my classroom? I begin with my primary theory, social constructivism, before shifting to the complementary lens of self-determination and the GRR model that supported my adapted instructional approach. As Merriam and Tisdell (2016) advised, these concepts “inform[ed] the study at hand” (p. 91), providing the “underlying structure or scaffolding” (p. 85).

Social Constructivism

A social constructivist approach to teaching and learning emphasizes knowledge as “developed jointly by individuals. This theory assumes that understanding, significance, and meaning are developed in coordination with other human beings” (Amineh & Asl, 2015, p. 13). Pritchard and Woolard (2010) emphasized three aspects of social constructivist thinking: reality, knowledge, and learning. Reality is based on shared human social activity and may vary based on experience. Because knowledge in the form of meaning and understanding results from social and environmental relations, learning is a lifelong process and only effective if individuals connect socially with others. During my study, students formed relations through group work in which they expressed themselves orally, kinesthetically, and in writing.

The principles of social constructivism emerged from Vygotsky’s extension of Piaget’s work on individual or cognitive constructivism, proposing social interaction as an essential aspect of learning (Powell & Kalina, 2009). According to Powell and Kalina
(2009), all students benefit from a social constructivist approach, due to the incorporation of “collaboration and social interaction” (p. 24). However, successful implementation requires familiarity with Vygotsky’s notion of the zone of proximal development (ZPD), which explains the different psychological functions that emerge as a child learns and grows (Pritchard & Woolard, 2010). Attending to the ZPD entails having students first work independently and then dependently receive help from the facilitator to learn new concepts related to the initial activity (Powell & Kalina, 2009). Figure 2.2 visualizes the ZPD and learner characteristics as a critical component of social constructivism.

![Figure 2.2 ZPD as a Critical Component of Social Constructivism](image)

Because the ZPD varies from student to student, “when students master completion of projects or activities in a group, the internalization of knowledge occurs for everyone at a different rate according to their own experience” (Powell & Kalina, 2009, p. 243). This principle was important to keep in mind, given my focus on Black students’ performance relative to their peers’ performance. Likewise, in a social constructivist classroom, while some students receive one-on-one attention from their teacher, group work among other students can facilitate their learning (Powell & Kalina, 2009). The intervention I designed to resolve my problem of practice reflects such a social constructivist approach to teaching and learning, as illustrated in Figure 2.3.
Designing this diagram helped situate my thinking and actions for my intervention, as well as my expectations for the students’ actions. As Figure 2.3 depicts, ensuring students receive adequate support to succeed requires a democratic teaching and learning environment, driven by student voice and interaction with peers to complete a given task. My role as the teacher researcher kept the constructivist learner in mind. This approach required modeling, scaffolding, and facilitating, such as using sentence stems, lesson prompts, and essential questions to encourage student inquiry. Moreover, a social constructivist environment should be inclusive, safe, and attractive. Therefore, I applied my understanding of the ZPD when adapting my approach to training students on how to make, support, and defend a valid claim, hoping to promote Black students’ independent and collaborative acquisition of STEM knowledge.

As an action researcher, I had to determine the students’ developmental levels in terms of their ability to solve problems independently and their potential for growth within the ZPD. While looking for evidence of growth, such as demonstration of critical
thinking and inquiry, I also reflected on the role of students’ self-determination.

Moreover, the gradual release model supported my aim for students to move toward independence throughout the intervention period. Becoming an independent learner requires building new knowledge and skills one can apply to problem-solving. Such achievement demands time for the intervention to be effective and measurable through the lens of the GRR framework and SDT. Alongside positive cognitive shifts, I expected my Black students to experience more autonomy, which could make them more confident, enable them to take control of their education, and help them become lifelong learners. My adapted approach thus promised to help students develop knowledge and skills that are transferable to real-life contexts.

As in Figure 2.3, I wanted a direct relationship with and among my students, supported by the social constructivist classroom environment. For example, teachers and students can access resources such as sentence stems and lesson prompts. The teacher can demonstrate for students how to use such resources when answering questions. Providing a respectful, nonjudgmental, democratic, safe, and attractive environment reinforces these relationships, increasing students’ willingness to participate, experiment, or explore. Such interactions build trust and confidence, expanding opportunities for students to be more independent as they increase their knowledge and skills.

**Self-Determination**

Coupled with social constructivism, “SDT is a macro theory of human motivation that stems from research on intrinsic and extrinsic motivations and expanded to include research on work organizations and other domains of life” (Deci et al., 2017, p. 19). A unique quality of SDT is that it outlines distinct types of motivation on a continuum.
based on the degree of self-determination or the perceived locus of causality: “when an action is self-determined, it is considered intrinsic, whereas it is viewed as extrinsic motivation when it is not self-determined” (Takahashi & Im, 2020, p. 675). Intrinsic motivation makes tasks “inherently enjoyable” (Takahashi & Im, 2020, p. 675), which is not always the case for school assignments.

SDT also highlights three basic human needs: competence, autonomy, and relatedness. Competence refers to one’s potential to do a task, autonomy refers to one’s sense of ownership of the task, and relatedness, in the context of a school, encompasses “associations between . . . teachers and students” (Fradkin-Hayslip, 2021, p. 199). As students interact with different stakeholders in their learning, they develop the confidence to take ownership of their learning and make decisions of whether to actively engage in and improve their performance. Figure 2.4 demonstrates how the concepts of SDT might motivate improved performance.

![Figure 2.4 SDT and Students’ Science Performance](image)

In Figure 2.4, SDT provides a pathway to understand how students are progressing from a constructivist perspective. Moore et al. (2020) used SDT to
demonstrate three key assumptions regarding college student enrollment in STEM courses: students’ sense of ownership over their learning, the significance of mastering tasks and skills, and students’ perception of belonging in STEM fields. Expounding on these constructs, Moore et al. described autonomy as an individual’s perceived control of their learning environment. For improved performance, students needed to feel in control of their learning environment and able to choose learning strategies that would give them maximum satisfaction. I applied this concept in my study by allowing students to participate in class activities orally, in writing, or kinesthetically, which I expected to improve their science performance, attitude, and behavior in conjunction with the other components of SDT.

Students also need to feel competent. Moore et al. (2020) described competence as the perception of having mastered a task or an individual’s positive affective response to learning and academic achievement, in line with my second research question. When underperforming students have “low perceptions of competence,” targeted intervention can “increase task engagement and performance” (Moore et al., 2020, p. 3). By adapting my approach to teaching students how to make scientific claims, support such claims with evidence, and explain their reasoning, I sought to improve Black students’ perceptions of their competence.

The final concept, relatedness, refers to the extent to which an individual feels their work connects with others, and according to Moore et al. (2020), because it can predict an individual’s engagement with an activity, interventions tailored to enhance relatedness can improve performance. The concept of relatedness thus informed my decision to examine students’ ability to collaborate with peers throughout the
intervention. Consistent with my third research question, I hoped to see them actively engage in science lessons as well as experiments. Relatedness as a concept also helped me gauge and record the frequency with which the students in question sought my help or tackled science problems in collaboration with peers.

In sum, autonomy, competence, and relatedness can motivate learners to improve their performance, and relatedness especially aligned with my intention to adopt a more social constructivist approach in my classroom. Both SDT and social constructivism emphasize teamwork among students. In my experience, students love working with peers or in groups, but sometimes this strategy is ineffective when students lack competence and autonomy in terms of skill and intrinsic motivation, meaning only some students are working and learning effectively. Students who are intrinsically motivated are likely to take initiative and actively engage in activities aimed at improving their mastery of STEM concepts compared to extrinsically motivated students. Getting students to that point required an additional lens: the GRR framework.

**Gradually Releasing Responsibility**

The CER strategy is students’ primary writing technique to decipher their learning in science classrooms. For students to master this strategy, they need an intentionally designed learning environment characterized by scaffolding lessons that offer teacher demonstration and guided and independent practice. Therefore, as I explained in Chapter 1, I also applied Fisher and Frey’s (2013) concept of teachers’ gradually releasing responsibility, so students become more independent learners. Illustrating how the GRR model aligns with students’ need for autonomy in accordance with SDT, Figure 2.5 describes how a student’s role changes as they acquire knowledge and skill over time.
According to Webb et al. (2019), the emergence of GRR helped popularize student-centered learning, and my application of the model was intentionally democratic. Students were free to speak, write, design their groups, and share resources such as sentence stems and other materials. I gave them a prompt, question, or experiment, and tasked them to respond, answer, or interpret the results, using the CER writing format to express themselves. Prior to this study, I expected students to understand that the hypothesis is a claim, observation represents evidence, and the conclusion is scientific reasoning. Changing how I presented the information had the potential to increase students’ confidence with their CER skills.

Cimino (2018) described four stages the learner must experience within the GRR model. Initially, the facilitator must actively model the task for student orientation before
providing students with guided practice. During guided practice, the teacher plays a more passive role as students become more active. The third phase is more collaborative and affords student teamwork, before students finally emerge as independent learners who accomplish tasks without teacher support. The GRR model guided my intervention toward improving Black students’ performance as I intentionally and gradually handed responsibility for learning to the students. However, because cognitive shifts may take several lessons, weeks, or months (Cimino, 2018), I tried to maintain realistic expectations for the outcome of my intervention. Nevertheless, GRR was a crucial feature of my action research that aligned with my social constructivist intentions for a classroom that is interactive, democratic, inclusive, and safe.

**Related Research**

A plethora of studies have explored instructional approaches to using the CER framework. Selvaggio (2020), for example, focused on allowing students to practice the skills between sets of pre- and posttests and found a positive effect on “Grade 8 science students’ writing skills, content knowledge, and attitudes towards writing in science” (p. 86). Guiding students through the CER framework improved their understanding and their ability to express that understanding when responding to constructed-response questions. Similarly, McNeill and Martin (2011) experimented with strategies for supporting elementary students through the difficulty of understanding their data and providing explanations based on evidence without minimizing learners’ excitement during hands-on investigations.

In another study at the middle school level, Alegado and Lewis (2018) recommended using the framework “as part of the actual inquiry investigation or as the
formative or summative assessment . . . with the whole class, in small groups, and with individual students” (pp. 77–78). According to the authors, the approach is especially successful when students receive guidance, which aligned with my GRR approach. The model’s distinct parts facilitate students’ ability to work at their own pace, thus meeting diverse needs. Although Alegado and Lewis added another R for “rebuttal,” they also recommended starting simple, with claim and evidence, before building increased rigor and relevance through scientific investigation over time.

Similarly, Osborne et al. (2017) included another component: the qualifier, a statement that “is only true for certain instances” (p. 5). Constructing a qualifier enables students to consider alternative perspectives. However, I focused on the traditional CER framework in case my students were not ready for additional steps. By providing sufficient scaffolding, I hoped to allow ample time for them to develop CER skills.

Reinforcing the need for a gradual approach, Ruiz-Primo et al. (2010) analyzed the quality of middle school students’ written scientific explanations and explored the link to students’ learning. Students’ explanations were scored based on the framework’s three components: a claim, supporting evidence, and reasoning that justifies the link between the claim and the evidence. Only 18% of the notebooks in the sample reflected the full framework, and 40% included claims without any supporting data. These findings prompted me to examine my students’ written work carefully.

Other studies also offered cautions for teaching CER skills. Novak and Treagust (2018) used a time-series design to explore how students modified their claim over four iterations of one explanation, which they termed an evolving explanation. Whereas close to “50% of the students were able to develop claims that matched all of the available
evidence,” the researchers noted “other students had challenges to adjust their claims when new evidence was obtained, even with class discussion, teacher feedback, and written scaffolds” (Novak & Treagust, 2018, pp. 544–546). Although “about 80% of students made appropriate claims after collecting two pieces of data” (Novak & Treagust, 2018, pp. 544–546), some students continued to offer partial, incomplete claims.

Barth-Cohen et al. (2021) also probed the use of evidence to revise models, examining seventh-grade students’ whole-class conversations about observational evidence in their conceptual models of magnetism. The authors presented several cases to show students’ productive reasoning using evidence while revising, challenging, and testing their scientific models. Overall results indicated that “middle school students are capable of sophisticated uses of evidence to support their reasoning when building and evaluating models” (Barth-Cohen et al., 2021, p. 15).

In another promising study, Gotwals and Songer (2010) described a system designed to elicit students’ intermediary knowledge on a path toward more sophisticated understanding. They found “students were often able to make claims and provide evidence (even if incorrect or insufficient) to back up their claims” (Gotwals & Songer, 2010, p. 278). The researchers determined even inaccurate or inadequate understanding can lead to a different type of messy middle knowledge that students display during more complex ecological scenarios, which has implications for curricular design and teaching.

For example, Short et al. (2020) suggested middle school students “benefit from [the CER framework] even when they are unfamiliar or in a new learning environment” (p. 56) but recommended using a structured discussion protocol to scaffold their understanding. Likewise focused on middle school, Song and Sparks (2019) encouraged
“innovative, formative assessment designs to provide valid and instructionally relevant information about students’ understanding” (p. 1193). As Chapter 3 explains, I specifically adopted their recommendation to explore performance and process data when examining students’ argumentation skills.

As evidence that the framework is useful across the curriculum, Duhaylongsod (2017) examined transcripts from six classroom debates from four different urban middle schools within a social studies curriculum designed to support student argumentation. The study recommended targeted assistance, “such as available evidence and sentence stems,” to help middle school students “do some of the heavy cognitive tasks demanded by debates” (Duhaylongsod, 2017, pp. 113–114). Although the nature of the study differed from mine, I also planned to use sentence stems as a scaffold to help students better understand and express themselves when enacting the CER framework.

Finally, Gryska and Zygouris-Coe (2019) demonstrated how CER-based instruction fostered students’ understanding of science concepts in Grades 3–5, and they also cited students’ increased engagement. This finding was especially relevant for my study. Because engagement plays a vital role in improving students’ science performance, attitude, and behavior, I resolved to design my intervention using social constructivist principles to ensure students could collaborate and engage.

Chapter Summary

Looking across related literature informed my attempt to address Black students’ underperformance in my science class. Underscoring the need to take action in my classroom, Croker and Buchanan (2011) argued, “Scientific thinking and reasoning skills underpin achievement in science education, and the development of these skills is
fundamental to becoming a scientifically literate adult” (p. 409). Both the studies I reviewed related to CER skills and the literature I cited to elaborate on my theoretical framework informed the design of my study. As Chapter 3 explains, using SDT as a lens helped me establish whether my adapted approach—rooted in social constructivism and the GRR model—helped students achieve competence with science tests, demonstrate autonomy when conducting scientific experiments with confidence, and relate with their peers as well as the subject of science. Consistent with the scholarship in this chapter, beyond evidence of improved performance in terms of their grades, I also hoped to see evidence of improved attitudes and engagement.
CHAPTER 3

METHODOLOGY

As I elaborated in the prior chapters, faced with the problem of Black students’ underperformance in my science class, I sought to adapt my instruction of CER skills, guided by my overarching research question: What happens when I take a more social constructivist approach in my classroom? More specifically, I explored the following questions:

1. How does adapting my approach impact my Black students’ grades?
2. How does adapting my approach impact my Black students’ attitudes?
3. How does adapting my approach impact my Black students’ behavior?

In keeping with my district’s equity-focused Black Excellence Resolution (Denver Public Schools, 2020), resolving my problem of practice would address the social and educational injustice experienced by Black students, and a successful action research study had the potential to ensure optimal performance for all my students.

Context and Sampling Plan

Consistent with action research (Efron & Ravid, 2013), the study site was my place of work, where the problem of practice emerged: a suburban, middle-class, predominantly White public middle school (i.e., Grades 6–8) in the western United States, which I refer to by the pseudonym Malcolm Middle. I also refer to students with pseudonyms. Malcolm Middle is a school of choice, and most of our students continue at the neighboring high school, another school of choice. At the time of this study, the total
student population was 561, with a student–teacher ratio of 16:9. The racial breakdown of
students at Malcolm was 53.3% White, 27.8% Hispanic, 7% Black or African American,
5.7% Asian, 5.3% two or more races, 0.7% American Indian, and 0.2% Pacific Islander.

Of the 198 sixth-grade students across my six classes, 17 (8.6%) were Black, all of whom were underperforming and thus represented the target population, ranging in age from 12–13 years. They scored poorly on classwork and exams, and most were classified as special needs, several with individualized education plans. Using criterion-based, single-stage sampling (Creswell & Creswell, 2018; Merriam & Tisdell, 2016), because I had insider knowledge of students’ relevant characteristics, I invited all 17 to participate. The sampling criteria—being a Black science student and underperforming—were consistent with my purpose and problem of practice (Efron & Ravid, 2013). This form of nonprobability or convenient sampling is appropriate for action research (Creswell & Creswell, 2018), given that the participants were easy to reach.

Before recruiting participants, I consulted relevant gatekeepers (Merriam & Tisdell, 2016) by completing the institutional review process at the university and district level and seeking administrative permission to conduct the study at my school. I then shared an invitation outlining my study with parental guardians and prospective participants (Appendix A). This process provided participants the autonomy or choice to participate. All 17 participants and their parental guardians accepted the invitation.

**Researcher’s Role**

As a science teacher at Malcolm Middle, I engaged my own students in this action research. To avoid bias or coercion, I supplemented objective assessments (Appendix B) with open-ended survey questions (Appendix C) pre- and post-intervention. As the prior
chapters indicate, I have my own philosophy regarding Black students’
underperformance in my class, but my research design enabled me to be as objective as
possible to promote equity and follow ethical guidelines. I implemented the intervention
to gain a better understanding of the underperformance of Black science students in this
setting so I could improve my ability to help students succeed.

**Research Design**

To achieve my research objectives, a convergent mixed-methods design was
appropriate. Collecting both qualitative and quantitative data concurrently and combining
the two sets through holistic analysis (Creswell & Creswell, 2018) enabled me to describe
students’ performance, attitudes, and behavior, in line with my research questions.
Looking across the complete data set could give me a sense of my intervention’s impact.
By adapting my approach, I sought to provide a more student-centered environment that
would improve students’ science performance.

I grounded the intervention lessons with principles of social constructivism, SDT,
and the GRR model. Specifically, the structure of my intervention included an
introduction to the CER framework to give students initial knowledge of how to apply
CER skills when answering a scientific question or prompt. Additionally, because the
CER aspect of the intervention included two units with a pre- and posttest for each,
students had multiple opportunities to collaborate with their peers, socially constructing
new knowledge while sharing responsibility. Such actions move them along the spectrum
from dependent to independent learner. Unit 1 included two lessons on weather patterns,
and Unit 2 comprised two lessons on ocean, atmosphere, and climate. As further evidence
of my theoretical framework’s influence, each lesson was student-centered. Students
worked with peers using the CER strategy to answer scientific questions, respond to the lesson prompt or problem, or cite evidence from experiments or articles I provided. I intentionally gave students multiple opportunities to showcase their learning. In addition to honoring each learner’s voice and choice, I also sought to ensure they remained engaged through collaboration. I expected completing activities as a team to reinforce their individual motivation, autonomy, and competence.

In prior years, my approach to teaching science was more teacher-centered. For example, although I gave students prompts and sentence stems, my process was not as intentional and structured to be student-centered. For this study, I adopted and modified Phillips’s (2018) six-sentence guidelines for implementing the CER framework, a structure that gave students a solid basis to learn how to use CER. The first sentence is a claim and focuses on answering the question; the second, third, and fourth sentences are evidence supporting the answer; the fifth is the explanation based on a scientific principle that proves the answer is correct; and the sixth is a conclusion that summarizes the evidence and restates the claim.

I modeled and scaffolded these six steps, using sentence stems and real-life, culturally relevant questions, lesson prompts, or experiments. This facilitation incorporated the social constructivist principle of the ZPD, which also aligns with the GRR framework. After I demonstrated how to use the stems, students collaborated to reinforce their knowledge and skills, which I expected to improve their performance.

Using SDT as a lens, I measured their progress during guided and independent practice activities. Even during the guided practice phase, I made significant pedagogical moves. To ensure students received intentional support (Fisher & Frey, 2013), I periodically
highlighted the purpose of the activities, modelled certain skills and concepts, and promoted students’ voices by helping them think aloud. When the responsibility shifted slightly from guided to independent practice, I employed rigorous questions, prompts, and cues to support students in applying new knowledge (Fisher & Frey, 2013). Throughout the independent learning phase, I expected students to take control of their learning and intervened only when they needed assistance. Simultaneously, I observed students to assess their motivation. In other words, I sought evidence of their competence, autonomy, and relatedness (Deci & Ryan, 2017). Ultimately, I used the school’s five-point scoring rubric to assess students’ performance—whether they exceeded, met, approached, partially met, or did not yet meet expectations.

**Procedure**

This study commenced in 2022. Table 3.1 briefly describes the research activities. I then elaborate on my data collection and analysis procedures.

Table 3.1 *Research Timetable*

<table>
<thead>
<tr>
<th>Date</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug.–Sept. 2022</td>
<td>1. Collected baseline data by administering the pre-intervention survey and starting the observation journal</td>
</tr>
<tr>
<td></td>
<td>2. Began the intervention by introducing the CER framework</td>
</tr>
<tr>
<td></td>
<td>3. Collected achievement and observation data throughout the:</td>
</tr>
<tr>
<td></td>
<td>Introduction to CER Lesson</td>
</tr>
<tr>
<td></td>
<td>Unit 1: Weather Patterns (pretest, two lessons, posttest)</td>
</tr>
<tr>
<td></td>
<td>Unit 2: Ocean, Atmosphere, and Climate (pretest, two lessons, posttest)</td>
</tr>
<tr>
<td></td>
<td>4. Collected follow-up survey data</td>
</tr>
<tr>
<td></td>
<td>5. Organized and analyzed all data</td>
</tr>
</tbody>
</table>

**Data Collection**

Data collection is the art of gathering information to support findings. In this study, qualitative data complemented the quantitative data. Collecting multiple types of
data facilitated triangulation—using a plethora of data sources or data collection methods to support prospective findings (Efron & Ravid, 2013; Merriam & Tisdell, 2016). Each method was critical to the study’s success. Figure 3.1 depicts how the tools I used to collect quantitative and qualitative data aligned with my research questions.

![Figure 3.1](image)

**Figure 3.1 Research Questions vs. Data Collection Tools**

**Quantitative Methods**

I answered Research Question 1, which focused on grades, primarily by using quantitative achievement data, beginning with the SLO based on Science Grade 6 argumentative writing as the recommended preparedness baseline. Before and after each unit within the intervention period, participants completed a teacher-made test through Schoology, our learning management system (Appendix B). I averaged the SLO data with the teacher-made pretest to determine overall preparedness prior to the intervention.

My sixth-grade science team usually meets once per month to discuss how to implement the CER format into each grade level’s curriculum, considering the unit
content, lesson objectives, duration of lessons, and unit assessment. This routine made implementing my intervention and assessing the outcome with pre- and posttests relatively easy by affirming my instructional decisions. I engaged in explicit instruction on how to use the CER format of argument writing in science before students completed the two units, employing the GRR model to encourage students’ shift toward independent learner status through development of competence, autonomy, and relatedness.

Each pretest encompassed the CER format and included one constructed-response question and four multiple-choice questions (Appendix B). At the end of each unit, participants completed a posttest consisting of the same five pretest questions and additional questions to cover the overall unit. After completing the pre-intervention survey, participants completed the first pretest via my online Schoology science page. I recorded the results and stored them for later analysis.

**Intervention**

The intervention consisted of my adapted approach to helping students learn CER skills to improve their underperformance in science. In an introductory lesson, I explained how to apply the CER strategy to quantitative and qualitative information from articles or text, experiments, or a hands-on activity. Phillips’s (2018) six-sentence structure for teaching CER was a good starting point for me to engage students in anticipation of Unit 1, which covered weather patterns and included two lessons over a span of 1.5 weeks. Unit 2 also included two lessons over a span of 1.5 weeks and covered topics related to oceans, climate, and atmosphere.

**Introduction to CER Lesson.** Implementing a social constructivist approach, aligned with the GRR model, played a vital role in how I got students to understand what
they were doing. When I introduced the CER framework, I highlighted what students should look for to cite a claim, identify evidence, and provide scientific reasoning. As Figure 3.2 shows, I used visual aids to explain alternative definitions for the word claim (e.g., hypothesis or prediction), so students could make a guess or take a stance about the answer to a question. I also explained that evidence might come from a text or by experimenting. Obtaining such evidence supports the claim and allows students to visualize and understand what is happening and how it is happening. Lastly, I explained that reasoning should always include scientific concepts (e.g., heat transfer).

**LESSON INTRODUCTION-CER**

| Claim: | A prediction or hypothesis  
| Answers a scientific question  
| Does not include “I” statements |
|---|---|
| Evidence: | data or observations from an experiment  
| a quote from text/article  
| supports the claim |
|---|---|
| Reasoning: | how evidence relates to the claim  
| why evidence is important  
| explains the scientific concept |

**Figure 3.2 Visual Aid From Introductory Lesson**

Referencing the visual aid in Figure 3.2, I asked what happened to the puddle, expecting students to respond with a claim. I prefaced the question with a background story describing heavy precipitation the previous day and provided additional scaffolding by outlining how to answer the question, using distinct colors to highlight the claim, evidence, and reasoning. I expected some students might not use the scientific word evaporate, and I was open to alternative vocabulary with similar meanings. My primary
objective was for students to connect variables such as hot day, evaporation, 90 degrees of temperature, and heat transfer, grasping how the CER framework can shape their scientific thinking and actions. As compared to my prior instructional approach, this lesson was more student-centered. I intentionally applied the GRR framework to support students’ progress.

**Unit 1: Lesson 1.** The first lesson in Unit 1 required students to participate orally and in writing to explain the differences between weather and climate by their respective variables using a flowchart or concept map. As a form of scaffolding, I provided a blank template of a Venn diagram for differentiating between weather and climate. Figure 3.3 is an example of a student’s finished work.

![Venn Diagram Image](image)

**Figure 3.3 Student Work Sample**

As further evidence of my social constructivist approach to this lesson, I allowed students to work in pairs as they used their creativity to construct flow charts that reinforced the differences between weather and climate. As students worked together, they communicated about how to design their diagrams to ensure they appropriately situated the concepts. Two examples appear in Figure 3.4.
I expected constructing the flow charts would help students grasp the appropriate concepts and practice sequencing and aligning information in advance of writing a CER response to a prompt or question. For example, in Figure 3.4, one student drew a flower to describe the weather elements reinforced with bold words such as wind, clouds, temperature, atmospheric pressure, precipitation, and humidity. The student then divided these elements into their components (e.g., the cloud types: cirrus, stratus, and cumulus). Being able to explain these basic constructs through a flow chart indicates students have mastered the concepts critical to producing a CER response.

**Unit 1: Lesson 2.** The second lesson in Unit 1 focused on weather fronts. The content language objective was for my students to construct, orally and in writing, models of different weather fronts and explain how their interaction contributes to various types of weather conditions (i.e., the language of comparing and contrasting). Continuing with my adapted instructional approach, I implemented the GRR model by first inviting them to identify and describe characteristics of the four types of weather fronts from a Pear Deck presentation. During this guided instruction phase, students recorded critical differences and similarities in their notebooks, and a brief class
discussion cemented their understanding. The lesson culminated in a more independent activity: students’ creating unique weather front models in pairs. To support their autonomy, I provided scissors, cardboard, Styrofoam, glue, tape, colored pencils, cotton, construction paper, copy paper, rulers, and straws, encouraging their free expression. During the model construction activities, students had a voice and choice about which materials to use. Figure 3.5 includes samples of their weather front models.

Figure 3.5 Models Created by Students

Unit 2: Lesson 1. In Unit 2, the primary objective was for students to explore significant ocean currents orally and in writing. Illustrating my continued use of the GRR approach, Lesson 1 began with an audiovisual presentation (Switzer, n.d.), as students recorded what they learned about ocean currents in their science notebooks. This note-taking strategy makes students more confident when participating in whole-class discussions. A brief student–student and teacher–student discussion followed to help
students cement their understanding of ocean currents. Next, they conducted an ocean-current experiment. Figure 3.6 shows the experimental setup before and after.

![Figure 3.6 Experimental Setup](image)

As students experimented, they recorded their observations, as illustrated in Table 3.2. Students then used the recorded data (i.e., evidence) to make sense of their hypothesis (i.e., claim) and provided a scientific justification (i.e., reasoning) for how the evidence they identified supported their claim. After students wrote up their lab report using CER strategies, they answered a CER practice question based on their lab report (Appendix B). Completing these practice questions allowed students to showcase their learning and provided opportunities for me to check how well students understood and applied the CER learning strategies.

Table 3.2 Example of Student Observations

<table>
<thead>
<tr>
<th>Warm Water (red color)</th>
<th>Cold Water (blue color)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Before putting it in with tap water, warm water moves faster</td>
<td>1. Before putting it in with tap water, cold water moves slower</td>
</tr>
<tr>
<td>2. Before putting it in with tap water, warm water moves faster</td>
<td>2. Sank to the bottom (Cold water molecules were closer together)</td>
</tr>
<tr>
<td>3. Lighter (less dense)</td>
<td>3. Before putting it in with tap water, cold water moves slower.</td>
</tr>
<tr>
<td>4. Floated (Warm water molecules further apart)</td>
<td>4. Moved faster once it was put into the tap water</td>
</tr>
</tbody>
</table>
Unit 2: Lesson 2. In Lesson 2, students read an article on the Gulf Stream (Appendix B). I asked them to identify and describe the characteristics of ocean currents and relate this experience to their ocean currents experiment from the previous lesson. To check students’ understanding of ocean currents and how effectively they used the CER strategies to answer a scientific question, I posed the CER-based prompt and asked students to analyze and interpret the data table in response.

Qualitative Methods

As noted, I checked students’ overall progress in response to the intervention by administering a pre- and posttest for each unit (Appendix B). To supplement this quantitative data, I also administered a survey before the first intervention lesson and after the last one (Appendix C) and had students complete a checklist for my observation journal at the end of each lesson (Appendix D). These methods gave me insight related to Research Questions 2 and 3, regarding students’ attitudes and behavior, and the surveys broadened my perspective of their achievement (i.e., Research Question 1).

Surveys. About 10 minutes before the introductory lesson, I asked students to complete the initial survey (Appendix C), which provided data related to their ability to use CER effectively. Administering an open-ended survey before and after an intervention enables researchers to gauge change (Fraenkel et al., 2015). Due to the pandemic, one-on-one interviews were not permissible, and virtual interviews would have required additional time on the part of students. Surveys were also more advantageous because students were already accustomed to taking surveys as a routine part of their school activities. Just as Durdella (2019) recommended aligning interview questions with interview dynamics, I designed my survey with clear objectives, using
Fraenkel et al.’s (2015) hierarchical approach, “beginning with the broadest, most general [questions] and ending with the most specific” (p. 393). This structure also encouraged my participants to go beyond yes and no answers and enabled me to understand their views related to how CER impacts their science performance.

I disseminated the surveys as Google Forms through Schoology so participants could take them simultaneously and independently. Each one lasted approximately 10–20 minutes. Participants had a chance to raise their hands so I could quietly answer any clarifying questions. Although the survey was virtual, hard copies were available for students who preferred to write their responses instead of typing. This consideration was vital because some students preferred written tests instead of online tests. If students were absent, they could take the survey when they returned. I typed all handwritten surveys and uploaded them into an encrypted Google Doc in a password-protected Google Drive, along with the digital surveys. In addition to ensuring data safety and security (Owan & Bassey, 2019), this procedure facilitated coding.

**Observations.** Observations provided an authentic perspective on what was occurring in my classroom (Efron & Ravid, 2013), namely with my students’ behavior. An observation journal including field notes and a checklist (Appendix D) thus helped me collect data in response to my third research question. The field notes were both descriptive and reflective. Daily, descriptive notes were objective, avoiding the subjectivity of providing my “feelings or responses to what is happening” (Efron & Ravid, 2013, p. 88). I concentrated on who, when, where, what, and how aspects of classroom happenings. Reflective notes gathered insights about occurrences in the research setting, giving special attention to the meaning of what I observed, my process,
any problems I faced, and my mindset. As Efron and Ravid (2013) advised, I focused on emerging interpretations. Specifically, the checklist (Appendix D) captured data on participants’ ability to use CER skills when answering constructed-response questions, orally or in writing. I used the checklist to track their behavior or activities over time.

**Data Analysis**

I made sense of my quantitative and qualitative data through a comprehensive data analysis strategy supported by social constructivism and SDT. This section describes the unique approach I took for each type of data. I also explain my efforts to ensure my study’s trustworthiness and quality.

**Quantitative Data Analysis**

After teaching the two science units in the intervention period and collecting all follow-up data, I used reputable software to make sense of my numerical data (Greasley, 2007), following Creswell and Creswell’s (2018) guidelines. First, I conducted descriptive analysis of pre- and posttest data (i.e., minimum, maximum, mean, and standard deviation). Then, I performed assumptions testing for paired t-tests, specifically including the normality of data. I calculated skewness and kurtosis as well as developed histograms to check if the normality assumption was met. Next, I conducted paired t-tests to test the central inferential research question or hypothesis. Finally, I presented the results in figures and tables, which appear in Chapter 4, along with my interpretation.

**Qualitative Data Analysis**

I also used software to assist me in storing, coding, analyzing, and organizing qualitative data. Efron and Ravid (2013) described qualitative analysis as “categorizing and coding procedures that identify units of meaning within the data” (p. 169). Creswell
and Creswell (2018) explained how sense-making “involves segmenting and taking apart the data (like peeling back the layers of an onion) as well as putting it back together” (p. 192). Within the software, I applied Braun and Clarke’s (2006) six-step model for qualitative analysis, seeking patterns or themes, knowing that “the ‘keyness’ of a theme is not necessarily dependent on quantifiable measures but rather on whether it captures something important in relation to the overall research question” (p. 82). This systematic and flexible strategy surfaced essential details relating to the students’ voices around their underperformance in science and the impact of my approach to teaching CER skills.

Figure 3.7 Six-step Model for Thematic Analysis of Qualitative Data

As Figure 3.7 illustrates, my initial step was becoming familiar with the data. I recorded initial ideas as I transcribed, read, and reread. Second, I generated initial codes of existing data features, systematically covering all sets for each code. Third, I searched for themes, which involved grouping codes into possible themes and obtaining all data relevant to each possible theme. For example, in one set of survey data, one student described a lesson as “Great, fun,” and another described it as “amazing.” Given that both
students had positive experiences, I grouped the data under the label of “student success” as evidence of how my social constructivist approach honored student voice. The students were able to give feedback about their learning. Fourth, I reviewed the themes by checking them against the coded extracts (i.e., Level 1 themes) and the entire data set (i.e., Level 2 themes). This step allowed me to create a thematic map by defining and naming the themes. After refining the specifics of each theme and the overall story by generating clear definitions and names, I produced the report of my findings in Chapter 4.

**Qualitative Internal Validity and Reliability**

Concerning the trustworthiness or validity of qualitative research, Jones and Donmoyer (2021) asserted, “bias stems, in part, from the fact that, in qualitative studies, researchers, themselves, are often the primary—and, in some cases, the only—research instrument” (p. 890). Therefore, minimizing bias in the qualitative aspect of my research could ensure trustworthy findings. Given the action research approach of the study, the findings were not generalizable, which means external validity was not a concern to the extent it is for traditional forms of research. However, I sought internal validity—or credibility—by ensuring my findings were reliable and consistent with reality (Merriam & Tisdell, 2016). Specifically, this chapter demonstrated my study’s methodological integrity by articulating how the problem, questions, theoretical framework, and procedures align. Second, through triangulation, I “validate[d] the accuracy of patterns and findings” (Efron & Ravid, 2013, p. 183), enhancing the study’s trustworthiness.

**Quantitative Validity and Reliability**

Ensuring trustworthiness and validity in mixed-methods research requires different approaches for quantitative and qualitative data. For the quantitative aspects of
this mixed-method study, I addressed the validity of my data collection tools—the teacher-made tests—and threats to internal validity, as Efron and Ravid (2013) recommended. With respect to reliability, I ensured my instruments were consistent, conducive to reproducibility, and indicative of content validity. Apart from asking my professor to vet my assessment items, I asked my content-area colleagues to peruse my instruments and make changes and suggestions as necessary. This process ensured that items matched learning objectives (Efron & Ravid, 2013), giving students chances to improve their science performance.

Another important aspect of my study was addressing threats to internal validity (Efron & Ravid, 2013; Fraenkel et al., 2015). To minimize mortality threat, I accepted all willing participants. To further ensure validity and reliability, I used the participants’ own words to reduce bias and remain reflexive in practice. Durdella (2019) explained that reflexive practice is an inquiry process that begins with questioning the role of the researcher and participants involved in a study and how these roles interact to contribute to the information in terms of ongoing practice and new knowledge. This practice of reflexivity occurred in every stage of the research process.

**Ethical Considerations**

Throughout my study, I was mindful of the ethical issues that could surface (Merriam & Tisdell, 2016). Creswell and Creswell (2018) explained the need to consider the applicable code of ethics before starting a study and at every stage of the study. As I explained, I sought university, district, and administrative approval as critical evidence that my study protected the participants’ rights and welfare. Upon completion of the study, the district received a copy of the final report as mandated.
Additionally, my invitation letter (Appendix A) notified participants of my intentions to maintain their confidentiality and privacy and assured them they could withdraw from the study if they so desired, without any negative consequences (Efron & Ravid, 2013). Participants chose their own pseudonyms, and I also use a pseudonym to refer to the school. Efron and Ravid (2013) explained the need for confidentiality of data regardless of the information. I also followed Creswell and Creswell’s (2018) suggestion to keep all raw data and other materials, such as digital data and all hard-copy materials, for up to 5 years after the study, after which I will safely dispose of the data.

Protecting participants was the most critical aspect of my research because children constitute a vulnerable population, although my action research study occurred in a traditional educational setting and involved routine educational practices (Durdella, 2019). Parental consultation played a significant role throughout the study to ensure no undue coercion of participants. In addition, I used “language appropriate for [participants’] age, maturity, and psychological state” (Durdella, 2019, p. 342) and ensured maximum benefits and minimum risk, attuned to the principle of justice.

**Summary**

This chapter provided a comprehensive explanation of my research design and my attempt to align my research methods, aim, questions, and theoretical framework. My intentional data collection and analysis strategies contribute to my findings’ validity and trustworthiness. Chapter 4 reviews the findings based on the quantitative and qualitative data I collected before, during, and after the intervention.
CHAPTER 4

FINDINGS

My mom always said a word fitly spoken is like a needle deftly threaded. This statement guided me as I examined participants’ words in conjunction with their science performance. Collecting data was tedious, but when I shifted to transforming and interpreting the data, I enjoyed identifying embedded patterns (Durdella, 2019).

Through convergent, mixed-method action research, I aimed to improve Black students’ performance in science. The SLO ELA Grade 6 argumentative writing report provided pre-intervention quantitative data on the students’ CER skills. I compared the results to post-intervention quantitative data and collected qualitative data to explore what happens when I take a more social constructivist approach in my classroom. More specifically, I posed the following questions:

1. How does adapting my approach impact my Black students’ grades?
2. How does adapting my approach impact my Black students’ attitudes?
3. How does adapting my approach impact my Black students’ behavior?

This chapter presents the outcomes of my study.

I begin with the findings from my qualitative data analysis using Braun and Clarke’s (2006) six-step procedures. Next, I report the results of the quantitative data analysis using descriptive statistics and the testing of parametric assumptions for statistical analysis. The chapter concludes with a discussion of the overall findings related to my research questions.
Qualitative Data Analysis

I compiled qualitative data from surveys and observations in spreadsheets, which I imported into analytical software. Students’ pseudonyms served as row headers, and survey and observation prompts served as column headers. I used the inductive procedure Braun and Clarke (2006) recommended, and this section follows the six steps: (a) familiarization with the data, (b) generating initial codes, (c) searching for themes, (d) reviewing themes, (e) naming and defining themes, and (f) presenting findings.

**Step 1: Familiarization with the Data**

Reading and rereading the spreadsheet files gave me a holistic familiarity with the data so I could identify patterns within and across responses (Braun & Clarke, 2006). I made handwritten notes about preliminary points of analytical interest, including repeated phrases and ideas. For example, the notion of writing better appeared in multiple student responses: Jane indicated CER skills helped her science grade “by making [her] a better writer,” and Hope wrote of the framework, “It helped when we had to write a paragraph.”

**Step 2: Generating Initial Codes**

I generated initial codes inductively by grouping bits of data with similar meaning and labeling those groups descriptively (Braun & Clarke, 2006). For example, the post-intervention survey asked students to share how learning CER strategies helped them earn better grades in science (Appendix C). Reb’s response, “CER strategies help me wright [write] good responses and get good grades,” resembled Jane’s answer, “By making me a better writer.” Both students emphasized becoming better writers, warranting the same code: grade improved post-intervention through better writing. This finding was prominent: 14 students credited their improved writing for better grades.
My theoretical framework also guided my coding. For example, I looked for references to student collaboration that reflected my social constructivist approach to instruction. During one observation, after Lesson 1, Shey wrote, “It was nice working together and helpful,” and Reb wrote, “It was good because we weren’t distracted, and we helped each other.” These responses informed the code, “Positive partnership experience in Observation 1,” which I applied to 12 other, similar responses. Table 4.1 indicates all the initial codes I identified during this step and the number of data excerpts associated with each.

Table 4.1 *Initial Codes*

<table>
<thead>
<tr>
<th>Initial code</th>
<th><em>n</em> (responses)</th>
<th><em>n</em> (observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CER helped in writing post-intervention</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Attitude toward science was neutral pre-intervention</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>No pre-intervention examples of CER use improving grades</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Peer collaboration improved performance post-intervention</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Positive partnership experience for Observation 3</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Positive partnership experience for Observation 4</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Grade improved post-intervention through better writing</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Peer collaboration improved CER use post-intervention</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Positive partnership experience in Observation 1</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>No pre-intervention peer collaboration with CER</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Attitude toward science remained neutral post-intervention</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Positive partnership experience during Observation 2</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Peer collaboration improved pre-intervention performance</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Peer collaboration did not improve performance pre-intervention</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Attitude toward science was more positive post-intervention</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Peers were helpful with CER use pre-intervention</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Grade improved post-intervention through learning CER strategy</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Peer collaboration did not improve CER use post-intervention</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Negative partnership experience for Observation 4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Negative partnership experience for Observation 2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Peer collaboration did not improve performance post-intervention</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Step 3: Searching for Themes**

My research questions guided me during Step 3, as I sought themes by grouping related codes (Braun & Clarke, 2006). For example, Question 2 focused on students’ attitudes, so I grouped three relevant codes: attitude toward science remained neutral
post-intervention, attitude toward science was more positive post-intervention, and attitude toward science was neutral pre-intervention. Then, as Table 4.2 indicates, I formed another preliminary theme from the 12 codes related to student performance and grades (i.e., Question 1), and a third from the nine codes related to student behaviors (i.e., Question 2).

Table 4.2 Grouping Initial Codes into Preliminary Themes

<table>
<thead>
<tr>
<th>Preliminary theme</th>
<th>Codes</th>
<th>n (responses)</th>
<th>n (observations)</th>
</tr>
</thead>
</table>
| **Performance**   | • Discrepant data - Peer collaboration did not improve CER use post-intervention.  
|                   | • Discrepant data - Peer collaboration did not improve performance post-intervention.  
|                   | • Discrepant data - Peers were helpful with CER use pre-intervention.  
|                   | • Grade improved post-intervention through better writing.  
|                   | • Grade improved post-intervention through learning CER strategy.  
|                   | • Help in writing from CER post-intervention.  
|                   | • No pre-intervention examples of CER use improving grades  
|                   | • No pre-intervention peer collaboration with CER  
|                   | • Peer collaboration did not improve performance pre-intervention  
|                   | • Peer collaboration improved CER use post-intervention  
|                   | • Peer collaboration improved performance post-intervention  
|                   | • Peer collaboration improved pre-intervention performance | 119 | 6 |
| **Attitudes**     | • Attitude toward science remained neutral post-intervention  
|                   | • Attitude toward science was more positive post-intervention  
|                   | • Attitude toward science was neutral pre-intervention | 33 | 4 |
| **Behavior**      | • Negative partnership experience for Observation 2  
|                   | • Negative partnership experience for Observation 4  
|                   | • Positive partnership experience during Observation 4  
|                   | • Positive partnership experience for Observation 3  
|                   | • Positive partnership experience for Observation 4  
|                   | • Positive partnership experience in Observation 1 | 57 | 3 |
While forming the themes depicted in Table 4.2, my theoretical framework guided how I grouped the codes. For instance, I observed citations that showed student collaboration in response to my adapted approach to teaching and learning. During one observation, Jala shared of her partnership experience, “it was good;” Zaric and Hope wrote, “We had fun;” and Zeek viewed his partnership as “awesome.” These positive partnership experiences supported my decisions about how to group codes into preliminary themes.

**Step 4: Reviewing the Themes**

Reviewing the themes involved comparing them to the original data to ensure they accurately reflected patterns of meanings in the participants’ original responses (Braun & Clarke, 2006). For example, I compared the preliminary theme “student attitudes” to the data to ensure all associated data indicated findings about student attitudes. I also engaged in cross-validation by comparing the themes to one another to ensure they did not overlap. Because student performance, student attitudes, and student behavior were readily distinguishable, I observed no overlap when looking across the preliminary themes.

**Step 5: Naming and Defining the Themes**

I named the themes to indicate the significance of the data assigned to them (Braun & Clarke, 2006). Whereas the preliminary labels indicated topics or categories, the names I applied during this step summarized and described what the data assigned to each theme indicated about the topic. I reviewed the data in full to assess its meaning concerning each theme. Table 4.3 displays the outcome of this process and illustrates how each theme aligned with a specific research question.
Table 4.3 *Finalizing Themes*

<table>
<thead>
<tr>
<th>Preliminary label</th>
<th>Finalized theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Theme 1: Students’ grades improved post-intervention through better writing and peer collaboration.</td>
</tr>
<tr>
<td>Attitudes</td>
<td>Theme 2: Some students indicated more positive attitudes toward science post-intervention.</td>
</tr>
<tr>
<td>Behaviors</td>
<td>Theme 3: Students reported and demonstrated predominantly positive behavior throughout the intervention.</td>
</tr>
</tbody>
</table>

**Step 6: Presenting the Findings**

I presented the findings by writing the following subsections. Each subsection focuses on a different research question, and thus, a different theme. I provide direct quotes from the data as evidence for all findings so readers can independently assess the integrity of the analysis.

**Research Question 1**

Question 1 focused on how adapting my approach impacts my Black students’ grades. Although my quantitative data primarily informed the response to this question, qualitative analysis yielded additional insight in Theme 1: students grades improved post-intervention through better writing and peer collaboration. This theme encompassed data from the pre- and post-intervention surveys, which I triangulated with my observational field notes.

Given how my theoretical framework influenced my approach to the intervention, the lenses of social constructivism, SDT, and the GRR model also shaped my interpretation of the changes in the students’ and my perceptions of their performance. For example, as students worked collaboratively to apply the CER framework to their writing, I observed the GRR model at work. Through the pre and post survey, students
shared that their grades improved after starting poorly, echoing my observations of their progress through the ZPD, transforming from dependent to independent learners (Fisher & Frey, 2013; Pritchar & Woolard, 2010).

The students attributed the improvement to their enhanced writing skills. Prior to the intervention, students did not associate the use of CER skills with peer collaboration, whereas post-intervention survey responses indicated stronger peer collaboration when using the framework. More generally, students were divided before the intervention concerning whether or not peer collaboration contributed positively to their performance in science, with nearly half of students reporting that it did not. However, after the intervention, almost all students perceived peer collaboration as making a positive contribution to their performance in science, suggesting peer collaboration had become more effective due to my adapted approach. The following subsections illustrate the contrast between students’ pre- and post-intervention survey responses.

**Pre-intervention Responses.** In their pre-intervention survey responses, 16 out of 17 students did not connect CER skills to earning a better grade in science and could not provide an example of a time when the framework had helped them earn a better grade. Responses to the question about their science grade included “what is CER” (Reb), “I don’t know” (Jala), “I do not know what that is” (Myia and Zaric), and “I was never taught CER strategies” (Zeek). Jane wrote, “they are just a writing format” and added, “confuses me.” Responses to the request for an instance when the framework benefitted their performance in science were similar, including “I don’t have one” (Prana), “N/A” (Kiki), “Don’t know” (Shey), “I’m not sure what ‘CER strategies’ is or are” (Hope), and “?” (Myia). Students’ general lack of knowledge about the framework prior to the
intervention could be attributed to a lack of exposure to this writing style. Students needed my scaffolding to apply this framework to learning scientific knowledge and skills. Therefore, these survey responses allowed me to improve the design and implementation of my adapted approach to bridge the gap regarding students' need for knowledge about the CER framework.

Only one student, Redwan, provided discrepant pre-intervention data indicating that CER strategies had helped him earn a better grade in science. Redwan wrote, “It [CER] helps you figure out something then help again when we were writing.” Asked to cite an instance when CER had helped him to earn a better grade, Redwan responded, “When we were writing an answer it helped me with that.”

Pre-intervention responses further indicated that working with peers did not help 12 out of 17 students use CER strategies to learn science content. Asked how working with peers helped them use CER, students provided responses such as “N/A” (Malachi, Kiki, and Shey), “what is CER” (Reb), “They don’t” (Jane), and “I don’t know” (Jala and Nawal). The students who provided discrepant data indicating that working with peers helped them use CER strategies gave generic responses that did not reference specific CER skills, including, “It helps me with working together” (Redwan), “By having help” (Prana), and “They can help you use it better” (Day).

Students were divided in their pre-intervention survey responses regarding whether working with their peers in any way helped them to improve their performance in science, with 10 students answering that peer collaboration helped them, and with the remaining seven students answering that working with their peers did not help them. Answers indicating benefits of peer collaboration prior to the intervention included “They
can help you use it better” (Malachi), “being help,” (Prana), “They can help improve my
to succeed” (Annika), and “I like to hear how other people think and how I
can improve my work from other people’s thoughts” (Zaric). Answers indicating that
peer collaboration did not improve science performance included “It doesn’t” (Alise and
Reb), “it does not benefit me it makes it worse” (Jane), and “N/A” (Kiki).

**Post-intervention Responses and Observations.** The most marked difference
between pre- and post-intervention responses was that after the intervention, 14 out of 17
students reported that the CER framework helped them earn a better grade in science by
improving their writing skills. For example, Reb wrote, “CER strategies help me wright
[write] good responses and get good grades.” Kiki shared, “We wrote a paragraph, and
my grade improved after that,” and Redwan responded, “It [CER] helped me get my
ideas out on a quiz and in an understandable way.” Jane indicated that CER skills helped
her earn a better grade in science “by making me a better writer,” and Nawal wrote, “It
strengthened my summary, and I got a higher grade.” Shey wrote that he earned a higher
grade because “CER provides all the framework that you need for a strong response so in
using it gets me good grades.” Hope wrote, “It helped when we had to write a
paragraph,” and Zaric stated that he used CER strategies to earn a better grade “by
creating a full answer.” The three students who did not report strengthened writing skills
in response to this survey item provided responses that indicated a misunderstanding of
the question, as with Miles responding, “Mr. Heath explaining,” and Zeek writing only,
“When we did the weather unit.” Thus, while almost all students were unable to cite an
instance prior to the intervention when using CER strategies helped them earn a better
grade in science, almost all students cited such an instance after the intervention.
Moreover, the instances students cited related to improvements in their writing skills, which I interpreted as a result of my social constructivist approach, as well as my use of the GRR model and SDT as lenses to monitor student progress. As students worked collaboratively with the freedom to express themselves kinesthetically, orally, and in writing, they developed the autonomy to take ownership of their work through the guided and independent phase of their learning. Simultaneously, I observed them as I gradually released control over their learning.

Asked more generally how CER strategies helped them in science class, all 17 students continued to provide responses focused on their strengthened writing skills. Alise wrote of CER strategies, “They help form my paragraphs and make them better,” and Redwan stated of the framework, “it makes explaining my opinion easier because I have a format to unravel.” Jala also referenced the paragraph as the unit of composition that CER strategies had helped her to improve, stating, “they help me write paragraphs,” and Nawal wrote, “they help make it easier to write a paragraph or summaries.” Hope explained how the framework “helps us right [write] strong claims,” and Myia wrote, “it helps me because it breaks down my writing strategies.” Day responded, “It helps with writing paragraphs a lot, and I prefer it that way.” Thus, students’ answers were consistent across survey items, indicating a strong perception that learning CER strategies was helping them earn better grades in science by improving their writing.

Throughout the intervention, students’ writing skills gradually improved, which I attributed to my adapted instructional approach. Again, the GRR and self-determination lenses shaped my interpretation of student performance, attitude, and behavior. While students worked collaboratively to complete hands-on activities, making choices about
their actions, they developed autonomy and confidence in their work through the guided and independent learning phases.

My own observation notes corroborated student responses to this effect, as I also perceived the benefits of my adapted approach to teaching the CER framework on students’ performance. After Unit 2, Lesson 1, I noted students’ applying the framework “to make sense of their experiments as they completed their lab reports. Each component of the students’ lab is segmented into CER format.” In the same entry, I documented improvement in students’ writing: “I felt confident that students were improving based on the quality of their written work.” I attributed this change to my use of “sentence stems that supported them in writing a claim, evidence, and reasoning response to a question.”

Another marked difference between pre and post responses appeared in students’ assessments of the benefits of peer collaboration. While 12 out of 17 students indicated prior to the intervention that peer collaboration did not help them to use CER strategies to perform better in science, almost all participating students—14 out of 17—indicated the opposite in their post-intervention surveys, stating that peer collaboration did help them to use CER strategies. Malachi suggested peer collaboration “basically gives you another brain to help you,” and Kiki responded, “I can get a different perspective on my work and get feedback.” Shey stated, “Working with peers helps me share my ideas with others,” and Zarin answered, “they [peer collaborators] can look at your work and tell you what you can do to make it better.”

These responses aligned with my observation of a marked improvement in student performance, attitude and behavior. I attributed this positive outcome to my adapted approach that prioritized culturally relevant and meaningful instruction that was inclusive
and supportive. For example, students had discretion to choose their roles when collaborating. The social constructivist nature of the lessons gave students multiple opportunities to learn from mistakes, ask questions of their peers and me, and make changes to improve their work. Based on my observation, they arrived earlier to class, paid more attention, and were less disruptive and even more thankful at the end of class.

Another vital contribution of my adapted approach was the use of the GRR and SDT lenses. While monitoring student performance with the help of these frameworks, I spent more time with struggling students than I typically would, gradually releasing those students who demonstrated mastery of CER skills. Likewise, SDT gave me the tools to identify positive shifts in student energy toward completing assigned tasks. Evidence of this change in attitude and behavior reflected their autonomy and motivation toward task initiation and completion. This persistence reinforced their ability to relate more to science lessons.

Notably, while the five students who indicated on the pre-intervention survey that peer collaboration helped them use CER strategies did not specifically reference CER skills in their responses, several students did in their post-intervention answers to the same question. Alise wrote, “Working with peers helped me with CER because we could collaborate and write a good claim, evidence, and reasoning.” Maya stated of her peer collaborators, “They help me with learning how to cite the evidence.” Annika’s response read, “Working with peers helps me use CER strategies to learn science content by giving me there [their] opinion on how my work is.” The three students who did not report peer assistance in using CER skills after the intervention did not provide specific responses, giving the answers, “N/A” (Jane), “I don’t know” (Miles), and “I hate working with
people” (Day). Therefore, not only did more students report peer collaboration in using CER skills after the intervention (i.e., 14 students after the intervention versus five students prior to the intervention), but most students’ responses also became more specific regarding how peers were helpful.

Again, I attributed this positive change in student responses regarding peer collaboration in using CER skills to learn science to my adapted instructional approach, viewed through the GRR and SDT lenses. Specifically, I saw evidence of a safe, inclusive, and democratic learning environment that fostered student participation as intended. Guided and independent practice reinforced student participation in lessons, enabling me to scaffold and support struggling students. In addition, my adapted approach was more inclusive, giving students a sense of belonging and ownership.

After the intervention, students also reported more positive perceptions overall of the efficacy of peer collaboration in helping them to perform well in science class. While seven students reported prior to the intervention that peer collaboration in general was not helpful, 16 out of 17 students described it as helpful after the intervention, suggesting my adapted instructional approach may have made peer collaboration more beneficial for these students. Kiki wrote that peer collaboration in general improved her performance in science because she could “improve [her] work by seeing things from another view,” and Prana responded, “we can share the results with each other.” Jane indicated peer collaboration helped “by giving [her] more ideas.” Maya stated, “I get better grades when I work with my partner because we share ideas,” and Shey responded, “Working with peers might reveal a response that I did not figure out yet.” Zeek wrote that peer collaboration helped him “understand more ways.” Thus, not only did most students
report that learning CER strategies helped them improve their grades by making them better writers, but they also indicated more positive experiences of peer collaboration both when using CER strategies and in general.

My reflective observation notes after Unit 1, Lesson 2, confirmed these benefits from peer collaboration in terms of students’ ability to complete the activity: “This lesson was a success because students enjoyed working with peers . . . and they focused on their tasks.” After Unit 2, Lesson 1, I further confirmed in my observation notes, “Students got more comfortable following instructions and communicating with their partners while doing hands-on activities.” In summary, students’ increasing comfort with and benefit from peer collaboration was reflected not only in their own post-intervention self-assessments, but also in my observations of their working together during the intervention lessons. These findings addressed Question 1, which focused on student performance. I attributed students’ success to my adapted approach that fostered peer collaboration and equitable academic support through hands-on activities.

**Research Question 2**

Question 2 was: How does adapting my approach impact my Black students’ attitudes? Theme 2 addressed this question: Some students indicated more positive attitudes toward science post-intervention. This theme also encompassed pre- and post-intervention survey data, triangulated with my observation notes. Overall, the findings indicate my adapted approach did not correlate with a change in most students’ attitudes toward science. On the pre-intervention survey, students described a typical science class in neutral terms. Without using evaluative language, they listed the tasks a typical science class comprised. Post-intervention survey findings were similar; most students continued
to describe a typical science class in terms of activities, which most of them reported without evaluation. The only change of note was that after the intervention, five out of 17 students who had used neutral or implicitly negative language prior to the intervention used explicitly positive terms to describe the typical class.

Before the intervention, all 17 students described science class in neutral, non-evaluative language. For Malachi, a typical class involved “starting off on pear deck then doing other things,” and Alise stated, “We join a pear deck, do an experiment, and fill out a lab report.” In Kiki’s perception, the typical science class required her to “sign into pear deck and begin a lesson,” and Redwan described how “we get in talk about our topic learn about it then write something.” Myia wrote, “In science I would sit down and learn about science things and then every now and then we do an experiment.”

For 12 out of 17 students, post-intervention responses were also neutral. Redwan, for example, wrote, “Learning about some sciencey thing and then doing one of these surveys which questions us on what we have learned.” Alise described a typical class like so: “We get on a pear deck and learn about the weather,” and Malachi wrote that in a typical class he would “Come in and sit down and do an experiment or a test or just a regular lesson.”

The other five students provided evidence of the intervention’s impact. Before the intervention, Prana wrote that a typical science class involved “Doing work.” After the intervention, Prana expressed an improved attitude in writing that a typical science class involved “Having science experiments and having fun.” Jala used neutral language in stating on her pre-intervention survey that in a typical science class, “I would probably go on pear deck website and do work on that website,” but then changed to more positive
terms in the post-intervention survey, using language similar to Prana’s: “Doing science experiments and having fun.” Day did not enter a response on the pre-intervention survey, but she provided a positive response on the post-intervention survey, stating that in a typical science class, “We are all learning something new every day.” Shey used neutral language to describe a typical science class prior to the intervention, writing, “We talk about whatever unit we are on then we do a little bit of writing. Sometimes experiment.” Shey specifically referenced CER strategies in his more positive, post-intervention response, writing that in a typical science class, “CER strategies provide a strong scientific answer and makes me feel confident in my response.” The most marked difference appeared in the responses from Jane. In her pre-intervention response, Jane expressed her negative attitude toward science by facetiously describing a typical class in these terms:

I go into class, get in my seat, class starts, I listen, I freak out and start hiding or hitting myself, I take a break, I come back, I draw and just listen, class ends, I pack up, I leave.

Jane’s post-intervention description of a typical science class as an opportunity to “sit down, learn, [and] do something fun” demonstrates a positive impact on her attitude. In addition to the promising sign in these instances of significantly more positive language in post-intervention responses, no students changed from neutral language to negative language. In other words, all students responded relatively well to my adapted approach. However, in my observation notes, I reflected, “students still needed more time during and after the intervention to express themselves on surveys better.”
My reflective observation notes from Unit 2, Lesson 2 corroborated these students’ responses: “I noticed an improvement in students’ attitudes.” My observation notes further indicated that one manifestation of students’ improved attitude toward and increased interest in science was that they were more expressive and engaged in their written responses: “I observed the quality of responses during student lessons pre and post intervention [increased] from single words to phrases or sentences. I found this change interesting because students expressed their thoughts and actions more.” My notes from those same lessons also indicated I had observed students’ improved attitude toward their own performance in the class: “An interesting point to note was that students displayed happiness with their performance.”

In summary, there were indications, both in students’ responses and in my own observations, that at least some students’ attitudes toward science improved during the intervention. Such positive changes in student attitude aligned with my vision for my adapted instructional approach, which incorporated opportunities for students to excel academically and socially through peer collaboration and equitable academic support. Throughout the process, utilizing the GRR and SDT models reinforced my adapted approach by helping me monitor changes in student attitudes in an intentional way.

**Research Question 3**

Question 3 focused on how adapting my approach impacted my Black students’ behavior. Theme 3 addressed this question: Students reported and demonstrated predominantly positive behavior throughout the intervention. This theme emerged from the observation journal entries—my students’ and my own. Therefore, this section also provides a narrative of the intervention period. To assess student behavior through
student self-report, I asked students to respond to a prompt during the last 5 minutes for each of the four intervention lessons to describe their experience working with a partner that day. These entries gave me insight into how well they and their partners performed the social and learning behaviors necessary for effective collaboration. Consistently, most students reported positive behavior throughout the intervention. Only three negative experiences of partnership appeared across the four observations, from three different students. I also conducted my own observations of the students during the lessons, recording descriptive and reflective field notes after each lesson.

In the introductory CER lesson, students participated in guided and independent practice. I introduced students to the differences between weather and climate using a Pear Deck presentation that allowed the students to type on the presentation slides. By the end of the lesson, the students could display the respective variables of weather and climate using a Venn diagram, flow chart, or concept map. My descriptive observation notes indicated of the strategy of using charts, “This process made learning easier, since I gave students a blank template of a Venn diagram that they used for differentiating between weather and climate.” This task was a group activity in which students worked in pairs. Of the 17 Black students who participated, 10 did well, earning four points out of a possible five points on the grading scale. My observation notes indicated that other students struggled: “In reflection, about five students have challenges using a Venn diagram or constructing concept maps.”

Most students reported decidedly positive experiences of partnership across all four observations. Shey wrote after Lesson 1, “It was nice working together and helpful,” and Reb wrote, “It was good because we weren’t distracted, and we helped each other.”
Kiki described her partnership in Lesson 1 as, “Great, fun,” and Day responded with one word, “Amazing.” My own observation notes from this lesson confirmed: “Through peer collaboration and opportunities for students to share ideas and use voice and choice, students received help from peers to complete their assigned tasks.” My observation notes further indicated an aspect of peer collaboration that students’ reflective journaling did not document, as follows: “The social constructivist approach to teaching and learning provide[s] students with additional peer support to complement their teacher. This teamwork between students allows me to do more one-on-one with struggling students.” Thus, by allowing the students to help one another—an experience that most students described as positive—I was able to focus my assistance on the students who most needed it.

Lesson 2 began with a quick reflection on Lesson 1. During the first 5 minutes of class, students revisited the Venn diagram and concept maps they created during the first lesson. The content language objective for Lesson 2 was for my students to be able to construct oral and written models of different weather fronts and use them to explain how interactions between fronts contribute to various weather conditions (i.e., the language of comparing). Using a Pear Deck presentation, I asked my students to initiate their learning by identifying and describing the characteristics of the four types of weather fronts from the presentation.

Students took turns reading the slides aloud, then I provided opportunities for the students to explain what they understood. I wrote in my descriptive observation notes, “During this lesson, the students recorded critical differences and similarities between the types of weather fronts in their science notebooks, followed by a brief class discussion to
cement their understanding.” The lesson ended with students’ creating unique weather front models in pairs. Students had a voice and choice about which materials to use and which design they preferred. Approximately 5 minutes before the lesson ended, students completed their observation checklist. At the end of Lesson 2, the students completed their posttest on weather and climate, using the CER framework to answer test questions.

After Lesson 2, responses remained markedly positive for most students, with Kiki, Jane, and Nawal describing their partnerships as, “Good.” Redwan wrote, “It was nice, because we had fun,” and Alise described her partnership as “Very fun and enjoyable.” My own observation notes confirmed: “This lesson was a success because students enjoyed working with peers, especially when they had a voice and choice about choosing their groups, materials, and project design.” I also noted the activities appeared to engage students effectively with the course content: “Students love the freedom of doing hands-on activities with their peers. Students were more engaged.”

One manifestation of student engagement was that the students sought feedback from me throughout the lesson, as I indicated in the following reflective note: “Students tend to ask me questions to ensure they are on the right track to completing their models.” My reflective notes further indicated that the weather front models the students constructed were an effective way to assess how well the students had understood the content of the lesson:

The completed weather front models provided a good indication of whether students were learning since the constructed model should match the content description in their class notes. In other words, the models allow students to translate the content notes into something tangible they created.
I also recorded in my reflection notes that some students continued to struggle with applying the CER framework when they answered questions in the posttest, a finding that I had expected, given that different students began the intervention with different levels of reading proficiency: “While some students effectively used the CER framework to answer questions, others struggled. This phenomenon could be attributed to some students’ reading and comprehension levels.”

Between Units 1 and 2, I modified my adapted approach to provide additional support to struggling students. For example, during Unit 1, I observed that some students lacked the CER skills to write a response to a scientific question or prompt. As a result, my practices became more intentional, focusing more on modeling how to respond to or answer a scientific question or prompt. I posted visuals of sentence stems or frames around the classroom and scaffolded how students should use the sentence stems to answer actual questions or prompts. Giving students these opportunities to practice and build their understanding of language skills and usage allowed them to write better CER responses to scientific questions or prompts. My observations indicated students often knew what they wanted to say in writing but needed help structuring their sentences. Learning how to use sentence stems gave students the structure to use their experience from experiments and constructing models, moving them closer to a proper scientific CER response.

Over time, the number of students who responded appropriately to a CER question gradually increased, which I attributed to my emphasis on student collaboration. As they critiqued the work of their peers by comparing the quality of the scientific claim, evidence, and reasoning, I displayed this peer feedback on a slide, making corrections to
anonymous student work in real-time for students to emulate. Tweaking my adapted approach between Units 1 and 2 resulted in students’ developing better writing skills, which improved their CER writing skills.

This continuous practice throughout the lessons aligned with the GRR model. As I documented in my observation journal, when I asked some of my previously struggling students if they needed help, they responded, “No” or “I got this, Mr. Heath.” Some also gestured with their heads, indicating they no longer need help. In such instances, I inferred the students were shifting from dependent to independent learners as they developed confidence and autonomy. I resolved to focusing more intentionally on critical aspects of my adapted approach as instruction shifted from Unit 1 to Unit 2.

In Unit 2, Lesson 1 began with the audiovisual presentation on ocean currents (Switzer, n.d.). As students viewed, they wrote brief notes on what they learned in their science notebooks. I then facilitated a brief discussion to help students cement their understanding of ocean currents. I recorded in my descriptive observation notes, “The note-taking strategy appeared to make students more confident when participating in whole-class discussions, since they could refer to their notes in real-time.” Moving to the ocean-current experiment, students recorded their observations in their lab report data table and used the recorded data to test their hypothesis, providing scientific reasoning to justify how the evidence supported their prediction. Finally, after students completed writing their lab report using CER strategies, they answered a CER practice question. I recorded in my descriptive notes, “Completing these practice questions allowed the students to showcase their learning and provided opportunities for me to check how well students understood and applied the CER learning strategies.”
Student reflections indicated that the positive experiences of working with peers continued through this third lesson. Malachi wrote, “It was pretty great. Me and my partner know how to work with each other,” and Reb wrote of his partnership, “It was good because we finished on time without getting distracted.” Hope provided a more nuanced response after this lesson, while still responding in positive terms, writing, “My group was good, the first time it was a little messy and we didn’t fully finish it but I think we nicely did it.” My reflective notes corroborated student responses indicating that their partnerships were effective: “Retrospectively, students got more comfortable following instructions and communicating with their partners while doing hands-on activities.” My reflective notes added to the students’ responses that the students appeared to be highly engaged during the activity: “As students used the procedures outlined in their lab to complete the ocean currents experiment, they were fascinated with the movement of the blue and red food coloring in the water.”

In Unit 2, Lesson 2, students discussed the Gulf Stream article, building from the previous lesson, and responded to the CER-based prompt, which proved particularly challenging for some students. However, their confidence grew once I modeled how to highlight the claim and supporting evidence in the article. I implemented my adapted approach by providing positive appraisals so students would feel included, and I observed more oral, kinesthetic, and in written participation in response. The SDT lens helped me to identify their increased engagement and motivation. From this perspective, I looked for instances of students’ autonomy, competence, and relatedness regarding a given task.

Another skill that some students needed to improve was reading a data table. I used the opportunity to teach students how to read and interpret the data table. Again,
students needed more time to understand how to apply this new knowledge, so when asked to connect the article they read and the ocean currents data table, they appeared more adept. This lesson culminated with the final observation checklist. Students then completed their second posttest and post-intervention survey.

After this final lesson, responses from most students remained positive. Jala wrote of her partnership, “it was good,” Nawal wrote, “I enjoyed working with a group because we got more work done,” Zarin and Hope stated, “we had fun,” and Zeek described his partnership as “Awesome.” Thus, most students described positive experiences of partnering with fellow students in the intervention lessons, suggesting the social and learning behaviors required for effective partnership were on display. Rooted in social constructivism, these positive experiences prompted me to credit my adapted approach for providing an environment conducive to learning. Students felt safe expressing themselves and completed group work—experimentation and model construction—democratically. I observed their autonomy, competence and relatedness (i.e., self-determination) as they enjoyed working together.

Only three discrepant responses appeared across the four observations. After Unit 1, Lesson 2, Day wrote of her partner, “They are really a distraction and annoying.” Day’s responses to the other observations were positive. After reporting positive partnership experiences through the first three lessons, Reb reported after Unit 2, Lesson 2, “My partners were good and working hard and trying our best but there was one person in my group that was not working hard and was playing around with our materials.” Similarly, after reporting positive partnership experiences over prior lessons, Miles wrote of his partner after Unit 2, Lesson 2, “They were not very good.” These
responses appeared to be anomalies, with students otherwise unanimously reporting highly positive experiences of collaboration.

**Presentation of Quantitative Data**

Consistent with my mixed-methods design, I also collected quantitative data. To compare students’ test results before and after each unit, I used the scale in Table 4.4, ranging from “not yet met” (0–29) to “exceeds” (90–100). After presenting the results chronologically, followed by Likert survey data, I address key parametric assumptions.

Table 4.4 *Grading Scale for Pre- and Posttests*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceeds</td>
<td>90–100</td>
</tr>
<tr>
<td>Meets</td>
<td>70–89</td>
</tr>
<tr>
<td>Approaching</td>
<td>50–69</td>
</tr>
<tr>
<td>Partially met</td>
<td>30–49</td>
</tr>
<tr>
<td>Not yet met</td>
<td>0–29</td>
</tr>
</tbody>
</table>

**Unit 1**

Unit 1 consisted of Lessons 1 and 2 that focused on weather patterns. Only one student (5.9%) met the passing criteria before the intervention, whereas after the intervention, seven (41.2%) met the passing criteria and one student exceeded expectations. Table 4.5 illustrates these results.

Table 4.5 *Unit 1 Results*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Pre</th>
<th></th>
<th>Post</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Exceeds</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>Meets</td>
<td>1</td>
<td>5.9</td>
<td>7</td>
<td>41.2</td>
</tr>
<tr>
<td>Approaching</td>
<td>10</td>
<td>58.8</td>
<td>4</td>
<td>23.5</td>
</tr>
<tr>
<td>Partially met</td>
<td>3</td>
<td>17.6</td>
<td>2</td>
<td>11.8</td>
</tr>
<tr>
<td>Not yet met</td>
<td>3</td>
<td>17.6</td>
<td>3</td>
<td>17.6</td>
</tr>
</tbody>
</table>
To measure an overall grade, I re-coded the variable from the grading scale such that 1 = not yet met, 2 = partially met, 3 = approaching, 4 = meets, and 5 = exceeds.

Using this criterion, pretest scores for Unit 1 ranged from 1 to 4 with a mean of 2.54 (SD = 0.87), and posttest scores ranged from 1 to 5 with a larger mean of 3.06 (SD = 1.25).

Table 4.6 displays these results.

### Table 4.6 Unit 1 Descriptive Statistics

<table>
<thead>
<tr>
<th>Test</th>
<th>Minimum</th>
<th>Maximum</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>1.00</td>
<td>4.00</td>
<td>2.54</td>
<td>.87</td>
<td>-.737</td>
<td>-.259</td>
</tr>
<tr>
<td>Post</td>
<td>1.00</td>
<td>5.00</td>
<td>3.06</td>
<td>1.25</td>
<td>-.561</td>
<td>-.805</td>
</tr>
</tbody>
</table>

**Unit 2**

Regarding Unit 2, one student (5.9%) met the passing criteria pre-intervention, whereas after the intervention, nine students (52.9%) met the criteria. However, unlike in Unit 1, no students reached the exceeds level of the grading scale. Table 4.7 presents these results.

### Table 4.7 Unit 2 Results

<table>
<thead>
<tr>
<th>Grade</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Exceeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meets</td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>Approaching</td>
<td>3</td>
<td>17.6</td>
</tr>
<tr>
<td>Partially met</td>
<td>4</td>
<td>23.5</td>
</tr>
<tr>
<td>Not yet met</td>
<td>9</td>
<td>52.9</td>
</tr>
</tbody>
</table>

Table 4.8 provides overall scores for Unit 2, reflecting the same adjusted coding approach I took with the scores from the Unit 1 assessments. Unit 2 pretests ranged from 1 to 4 with a mean = 1.76 (SD = 0.97). Posttests ranged from 2 to 4 with a greater mean of 3.35 (SD = 0.79).
Table 4.8 *Unit 2 Descriptive Statistics*

<table>
<thead>
<tr>
<th>Test</th>
<th>Minimum</th>
<th>Maximum</th>
<th>$M$</th>
<th>$SD$</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>1.00</td>
<td>4.00</td>
<td>1.76</td>
<td>.97</td>
<td>.997</td>
<td>-.055</td>
</tr>
<tr>
<td>Post</td>
<td>2.00</td>
<td>4.00</td>
<td>3.35</td>
<td>.79</td>
<td>-.760</td>
<td>-.862</td>
</tr>
</tbody>
</table>

**Likert Data**

To supplement the assessment data, I also collected quantitative data via the pre- and post-intervention survey (Appendix C). Students responded to the question, “How important is it to learn claim, evidence, and reasoning as a Black science student?” The corresponding Likert scale ranged from 1–5, or not at all important to very important. Table 4.9 provides pre- and post-intervention descriptive statistics. Before the intervention, my participants’ responses ranged from 2 to 5 with a mean of 3.88 ($SD = 1.22$). After the intervention, their responses ranged from 3 to 5, with a greater mean of 4.29 ($SD = 0.59$).

Table 4.9 *Survey Descriptive Statistics*

<table>
<thead>
<tr>
<th>Test</th>
<th>Minimum</th>
<th>Maximum</th>
<th>$M$</th>
<th>$SD$</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>2.00</td>
<td>5.00</td>
<td>3.88</td>
<td>1.22</td>
<td>-.688</td>
<td>-1.108</td>
</tr>
<tr>
<td>Post</td>
<td>3.00</td>
<td>5.00</td>
<td>4.29</td>
<td>.59</td>
<td>-.109</td>
<td>-.325</td>
</tr>
</tbody>
</table>

**Testing of Parametric Assumptions**

To determine if pre- and post-intervention scores were significantly different, I conducted paired $t$-tests. First, I had to verify some assumptions: the normality of the difference scores and the absence of outliers. Visual inspection of histograms for the two units indicated approximate normality (Figure 4.1). The peak or mound-shaped distribution with approximate symmetry in each panel suggests the two distributions are approximately normally distributed.
Additionally, I used skewness and kurtosis indices to identify the normality of the data (Table 4.10). The results suggested the deviation of data from normality was not severe, as the skewness and kurtosis values were below 3 and 10, respectively (Kline, 2011). To detect outliers, I generated standardized scores. No standardized values fell outside three standard deviations, indicating no outliers in the data.

Table 4.10 *Skewness and Kurtosis Values*

<table>
<thead>
<tr>
<th>Difference</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff1</td>
<td>-.607</td>
<td>.195</td>
</tr>
<tr>
<td>Diff2</td>
<td>.032</td>
<td>-.670</td>
</tr>
</tbody>
</table>

The pre- and post-intervention survey results regarding the importance of learning CER also indicated approximate normality of difference scores as suggested by the histogram in Figure 4.2. Additionally, skewness and kurtosis values suggested no violation of the normality assumption. Also, no standardized values fell outside three standard deviations, indicating no outliers in the data.
Quantitative Data Analysis

To analyze my quantitative data, I performed descriptive and inferential statistics to address two research questions:

1. How does adapting my approach impact my Black students’ grades?
2. How does adapting my approach impact my Black students’ attitudes?

For the first question, I used dependent paired $t$-tests. Regarding Unit 1, there was no significant mean difference between pre- ($M = 2.53, SD = 0.87$) and posttest scores ($M = 3.06, SD = 1.25$). The mean difference of -0.53 was not significant, $t(16) = -1.774, p = .095, 95\% CI [-1.16, .10]$. Regarding Unit 2, the mean difference of -1.59 from pre ($M = 1.76, SD = 0.97$) to post ($M = 3.35, SD = 0.79$) was significant, $t(16) = -1.774, 95\% CI [-2.07, -1.11], p < .001$. Table 4.11 summarizes this information.

Table 4.11 Paired Samples Test for Research Question 1

<table>
<thead>
<tr>
<th>Unit</th>
<th>Paired Differences</th>
<th>95% CI</th>
<th>$T$</th>
<th>$Df$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$SE$</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>1</td>
<td>-0.53</td>
<td>1.23</td>
<td>.30</td>
<td>-1.16</td>
<td>.10</td>
</tr>
<tr>
<td>2</td>
<td>-1.59</td>
<td>.94</td>
<td>.23</td>
<td>-2.07</td>
<td>-1.11</td>
</tr>
</tbody>
</table>
For the second question, I also conducted a dependent paired $t$-test. I determined
the mean difference of -0.41 from pre ($M = 3.88, SD = 1.21$) to post ($M = 4.29, SD =
0.59$) was not significant, $t(16) = -1.807, p = .090, 95\% CI [-.89, .07]$. Table 4.12
provides these results. Although my research design did not allow for definitive causal
claims, this analysis gave me some sense of the impact of my adapted approach.

Table 4.12 Paired Samples Test for Research Question 2

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>SE</th>
<th>95% CI</th>
<th>t</th>
<th>Df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-.41</td>
<td>.94</td>
<td>.23</td>
<td>-0.89</td>
<td>-1.807</td>
<td>16</td>
<td>.090</td>
</tr>
</tbody>
</table>

Chapter Summary

The purpose of this convergent, mixed-method action research study was to
improve my Black students’ science performance through a more social constructivist
approach. The SLO ELA Grade 6 argumentative writing report on recommended
preparedness provided initial quantitative data on participants’ ability to use CER skills
by confirming the need for improvement. After adapting my approach to meet this need, I
compared pre- and post-intervention quantitative data in conjunction with qualitative data
collected throughout the study.

Quantitative analysis utilizing dependent paired $t$-tests indicated an increase in
participants’ grades, thus answering Research Question 1. Specifically, regarding Unit 2,
the mean difference of -1.59 from pre ($M = 1.76, SD = 0.97$) to post ($M = 3.35, SD =
0.79$) was significant, $t(16) = -1.774, 95\% CI [-2.07, -1.11], p < .001$. However, there was
no significant mean difference for the first unit. Furthermore, there was no significant
mean difference from pre to post regarding the intervention’s impact on Black students’
attitudes (i.e., Research Question 2). Nevertheless, the qualitative findings affirmed the positive impact related to Question 1 and offered additional insight related to Question 2.

Qualitative analysis indicated students did not connect CER skills to their grades prior to the intervention, but after the intervention, the students unanimously attributed their improved grades to their use of the framework. The students especially emphasized their improved writing skills. Additionally, post-intervention survey responses indicated stronger peer collaboration when using CER skills. More generally, students were divided prior to the intervention concerning whether or not peer collaboration contributed positively to their performance in science, with nearly half of students reporting that it did not. Prior to the intervention, my observations also aligned with the students’ view regarding whether peer collaboration positively impacted students’ science performance. Understandably, I expected the students to express this challenge as it underscores the problem of practice that prompted me to adapt my instructional approach.

After the intervention, almost all students perceived peer collaboration as making a positive contribution to their performance in science, suggesting my adapted approach had a positive impact. My observations confirmed this positive shift in their performance due to peer collaboration, which I attributed to my social constructivist approach backed by the GRR model and my understanding of SDT. My intentional use of positive appraisals, orally and in writing, reinforced the students’ positive interactions with one another. This mutual classroom respect allowed students to learn from their mistakes without ridicule, which in turn, contributed to their growth.

Regarding Question 2, some—not most—students indicated more positive attitudes toward science post-intervention. Pre-intervention survey findings indicated
students described a typical science class in neutral terms, without using evaluative language. Post-intervention survey findings were similar, yet five out of 17 students who had used neutral or implicitly negative language prior to the intervention used explicitly positive terms to describe the typical class.

For this aspect of the study, my perspective differed from that of my students, as my observation notes documented most students’ positive attitudes toward science post-intervention. Evidence included promptly completing assigned tasks and interacting positively with their peers and with me. Additionally, students frequently referenced how they enjoyed the lesson at the end of each class. One possible explanation for students’ negative responses is their frustration with having to complete a large number of school-related surveys. Frankly, they did a good job completing the surveys for my study in contrast to their typical reaction to surveys.

Finally, qualitative data also addressed Question 3, illustrating how students reported and I observed predominantly positive behavior throughout the intervention. Students’ responses to observation journal prompts consistently reported positive behavior throughout the intervention. Only three negative experiences of peer partnerships appeared across the four observations. My observations between Units 1 and 2 aligned with their positive reports. Looking across the three research questions, Chapter 5 includes further discussion and recommendations based on these findings.
CHAPTER 5

IMPLICATIONS

Through convergent, mixed-method action research, I aimed to improve my Black students’ performance in science. Mindful of broader achievement gaps between White students and their Black and Hispanic counterparts (Hussar et al., 2020), I also recognized how racism, classism, and sexism can impede marginalized students’ academic opportunities, particularly in STEM fields (London et al., 2021). To resolve this problem of practice, I sought to enhance students’ use of the CER framework by adjusting my instruction, guided by the following research questions:

1. How does adapting my approach impact my Black student’s grades?
2. How does adapting my approach impact my Black students’ attitudes?
3. How does adapting my approach impact my Black students’ behavior?

To ensure a holistic and in-depth investigation of the phenomenon of interest (Creswell & Creswell, 2018), I collected qualitative and quantitative data.

As Chapter 4 revealed in response to Research Question 1, qualitative analysis of survey and journal data suggested my adapted approach improved students’ science performance by enhancing their writing and peer collaboration skills. For Research Question 2, the qualitative analysis suggested the intervention positively influenced some students’ attitude toward science. The qualitative findings regarding the third research question further revealed a positive impact on behavior in terms of student engagement.
For the most part, participants enjoyed completing assigned tasks throughout each intervention lesson, reflecting a change in response to my adapted approach.

Quantitative analysis also addressed Research Questions 1 and 2, examining whether adapting my approach impacted participants’ performance and attitudes toward science. Descriptive and inferential statistical analysis revealed that Unit 1 did not significantly impact participants’ grades and attitudes. However, after Unit 2, students’ grades improved significantly, despite no quantifiable change in students’ attitudes toward science. Overall, therefore, I concluded that the intervention succeeded.

In this chapter, I discuss and interpret these findings in conjunction with related literature and through the lens of my theoretical framework: social constructivism, SDT, and the GRR model. I also share recommendations for practice, discuss how I will implement the findings, and reflect on my action research methodology, including the study’s limitations. The chapter ends with an overall summary of key points.

**Discussion of the Results Using Related Literature**

I conducted action research because my Black students consistently underperformed in sixth-grade science. I aimed to investigate whether adapting my instructional approach would not only improve their performance but also improve their attitude and behavior. I analyzed both qualitative and quantitative data to address my research questions; therefore, this section addresses each set of outcomes in relation to existing literature.

**Discussion of Qualitative Findings**

Chapter 4 introduced three themes I gleaned from my qualitative data. First, I determined that students perceived their grades as improving post-intervention through
better writing and peer collaboration. Second, I demonstrated how some students indicated a more positive attitude toward science post-intervention. Finally, data indicated students reported and demonstrated predominantly positive behavior throughout the intervention.

**Theme 1**

Based on qualitative analysis, students’ science performance improved through peer collaboration and enhanced writing capabilities, which I attribute to my adapted approach grounded in social constructivism and the GRR model. I intentionally designed student-centered lessons with hands-on activities that incorporated collaboration, voice, and choice. This democratic approach allowed students to share ideas as they applied CER principles to specific tasks. Across Units 1 and 2, as I enacted the GRR model, I measured student performance in terms of their increased knowledge and skills, indicating improved competence and autonomy through the lens of SDT. As a result, in contrast to students’ pre-intervention responses, their post-intervention responses referenced the CER framework and peer collaboration as enhancing their analysis and writing skills and fostering sharing of ideas. These findings echo Selvaggio’s (2020) investigation of Grade 8 students’ use of the CER framework: participants’ improved understanding of scientific concepts was especially evident in their writing.

My students’ post-intervention references to their stronger writing skills specifically cited developing good paragraphs. Likewise, Alegado and Lewis (2018) found that teaching CER skills encouraged students to think critically about science concepts and present their findings through accurate writing. Similarly, Ruiz-Primo et al. (2010) demonstrated that using the framework improved students’ presentation skills, and
Barth-Cohen et al. (2021) showed comparable results with Grade 7 students. Consistent with these prior studies, I believe my social constructivist approach improved my participants’ science performance by enhancing their CER skills.

Qualitative analysis also revealed improved performance through peer collaboration and engagement with scientific concepts. My lessons intentionally incorporated discussion to promote sharing of diverse ideas that could enhance student understanding. Students’ increased confidence when engaging in scientific discussions with peers and conducting scientific experiments addresses prior calls for more research on the development of students’ argumentation skills (Song & Sparks, 2019). My adapted approach, by emphasizing peer collaboration and scaffolding students’ use of the CER framework, helped students understand and respond to complex science problems. Likewise, Gotwals and Songer (2010) found CER-based instruction improved students’ understanding of sophisticated concepts.

**Theme 2**

I developed my second research question to investigate whether the intervention influenced students’ attitudes toward science. Qualitative analysis of survey data revealed a positive influence. The students attributed their change of attitude to the fun of conducting science experiments, their ability to understand and respond to scientific concepts, and their improved confidence in presenting scientific claims with supporting evidence. Likewise, Alegado and Lewis (2018) argued CER-based instruction endows students with the confidence and ability to think independently. Moreover, having fun during science experiments and other practical activities positively influenced their interactions with peers as well as me.
Theme 3

The third theme responded to the third research question regarding how adapting my approach impacted my students’ behavior. Most of the positive responses in my observational journal emphasized students’ engagement with each other, how they worked as a team during practical lessons, and the amount of work they accomplished as a group. Short et al. (2020) reported similarly positive findings when incorporating discussion as a means of teaching CER skills. Although some of my students reported negative behavioral experiences, arguing that peer collaboration was distracting or other students were uncooperative, my adapted approach was successful overall.

Discussion of Quantitative Findings

Quantitative analysis also informed my examination of how the intervention impacted Black students in my science class. Given students’ improved scores after Unit 2, quantitative results confirmed the qualitative findings that adapting my approach improved students’ performance. Based on the qualitative analysis, enhanced peer collaboration coincided with improved engagement and performance. Thus, I concluded that adapting my approach to introducing and facilitating students’ use of the CER framework improved my students’ performance in science. I must note, however, the quantitative results revealed no influence on students’ attitude toward science, contrary to the qualitative findings.

Combining both methods suggests the intervention was successful overall in that it improved participants’ writing skills, analysis of scientific claims, and presentation of supporting arguments by fostering peer collaboration and student engagement. When I adapted my approach, students were motivated to engage with their peers as well as with
me. As the instructor, I helped them in refining, supporting, and defending their claims while gradually releasing responsibility for their learning to reinforce their self-determination. This enhanced collaboration and engagement also correlated with improved grades, attitude, and behavior. As Short et al. (2020) found, students have an overwhelmingly positive attitude toward the CER framework because they are drawn to strategies that improve their performance and put them on par with other high-performing students. Likewise, my Black students embraced the CER framework because it improved their ability to engage and collaborate with peers, consistent with my vision for adapting my instructional approach.

I must note that my intervention did not focus on all factors that might improve Black students’ science performance. My literature review highlighted the importance of attendance (Lasky-Fink et al., 2020), the availability of Black role models as science teachers (Leath et al., 2020; Milner, 2016), and the need for parental support (Leath et al., 2020; Marcucci, 2020). Therefore, coupling the positive impacts of my intervention with a focus on other factors may further increase the science performance of Black students.

**Practical Recommendations**

A few practical recommendations emerged from this study. First, I recommend using a social constructivist approach when teaching CER skills, extending the focus to supporting all underperforming students across racial groups. As Selvaggio (2020) found, the CER framework can improve students’ understanding of science and ability to express their scientific claims logically. However, learning these strategies can be challenging in an ineffective classroom environment. The way I structured my lessons was key, so I recommend my intervention approach to fellow practitioners.
My second recommendation is administrative. Given the intervention’s positive impact on Black students’ performance, administrators should encourage incorporating and integrating the CER framework into the student curriculum more intentionally, perhaps through targeted opportunities for teacher training. Instruction from a social constructivist lens would support diverse learners in understanding the basics of identifying a scientific claim and how to support their claims with evidence and adequate reasoning, especially when combined with the GRR framework.

**Implementation Plan**

I intend to share my findings to ensure they achieve their intended purpose. First, publishing my dissertation can ensure my findings reach the target audience: fellow practitioners. I also used my school’s weekly professional development structure to present my findings to my colleagues and emailed a copy to my district office.

By sharing my findings with interested colleagues, I invited their input on how to implement the recommendations not only in our school but also in neighboring schools. For instance, I sought an audience with the academic faculty and school administration, where I presented my study and the implications of my findings. I aimed to convince others to use my adapted approach situated in social constructivism. I also intend to share the findings of future action research cycles.

**Reflection on Action Research Methodology**

Writing this dissertation has been laborious, including drafting and redrafting the proposal to achieve the desired outcome. However, the demanding process has also been rewarding, as I have experienced immense mental and academic growth from studying the impact of my social constructivist approach. Specifically, I enjoyed witnessing
students’ engagement when collaborating with their peers and observing their progress with using CER skills to make sense of their learning. Implementing voice and choice seemed to remove barriers and allow students to express themselves freely.

Additionally, the surveys and checklists provided space for students to reflect and take ownership of their learning over time, consistent with my use of the GRR model. Their cooperation in this regard was unexpected, as students generally express hatred toward schoolwide surveys. I also learned to ensure adequate time for students to complete their surveys. Novice researchers should be cognizant of this possible error when collecting data.

With the numerous challenges and unexpected experiences came immense opportunities to develop my research skills. Using both qualitative and quantitative data helped me achieve my aim, and I developed my critical thinking skills when reviewing and synthesizing literature. The personal value of this action research process includes the skills and experience I have gained, which can inform my future work.

At the same time, my study was also limited. First, as is typical of action research (Hays & McKibben, 2021), my sample of 17 students was small, so the findings are not generalizable, despite my mixed-method approach. However, Hays and McKibben emphasized naturalistic generalizability as a means to ensure transferability. Therefore, I attempted to provide adequate contextual information. Because duration is also a limitation of action research (Ross-Fisher, 2008), a longer intervention might have made my study more conclusive. Given these limitations, scholars should consider two major recommendations for future research. First, because a small sample size hindered the generalizability of my findings, future research should include a larger sample size.
Second, given the geographical limitation of the research setting, using participants and sites throughout the United States would enhance generalizability.

Retrospectively and introspectively, I wish I had actual artifact data on students’ use of the CER framework. I regret overlooking this important aspect of classroom action research. Including such artifacts would improve the trustworthiness of my observations of students’ progress and supplement the comparison of pre and posttests. As one of my committee members suggested, “a good dissertation is never finished.”

Additionally, given how critical the design of the study was to student success, my use of data collection instruments could have been more effective. For instance, my dissemination plan was too hasty in that I could have been more organized to allow students to complete the surveys in a timelier fashion. Spacing when students took the survey would have given them more thinking time and rest period to provide more thoughtful responses.

Moreover, I spent more time focusing on student-related data collection and overlooked the need to place more emphasis on my field notes. This imbalance in the data collection, relying so heavily on students’ self-reports, limited the strength of my findings. In hindsight, I should have set up a more structured and intentional system of collecting field notes. Novice researchers in the academic setting should be especially vigilant and proactive when considering scheduling logistics (Fusch et al., 2022). Instead, I was reactive—one of my downfalls as an action researcher. On days when my schedule changed, I was unprepared. Although the data collection, collation, and analysis process can be stressful for all researchers, I am confident I can improve my research practices based on this initial experience.
Summary

The problem I addressed in this convergent, mixed-method action research was the underperformance of Black students in my science courses. Using qualitative and quantitative data collected from 17 students, I determined that implementing a social constructivist approach improved their grades and positively influenced their attitude and behavior in science. My effort to improve my Black students’ performance, attitudes, and behavior aligned with my school district’s aim for social justice on behalf of marginalized students. My role as the action researcher was to ensure that my students receive equitable support by teaching them to use CER effectively to learn science. Moving forward, I intend to continue addressing the underperformance of my Black students in science as compared to their White counterparts.
REFERENCES


Mickelson, R. A. (2003). When are racial disparities in education the result of racial
discrimination? A social science perspective. *Teachers College Record, 105*(6),
1052–1086. https://doi.org/10.1111/1467-9620.00277


practice: Using self-determination theory to better understand inclusion in STEM.
*Journal of Microbiology & Biology Education, 21*(1).
https://doi.org/10.1128/jmbe.v21i1.1955

Nogueira, P. (2019, July 8). Equity isn’t just a slogan: It should transform the way we
educate kids. *Insight. The Holdsworth Center.*
https://holdsworthcenter.org/blog/equity-isnt-just-a

students incorporate new evidence into their scientific explanations? *Journal of

*Arguing from evidence in middle school science: 24 activities for productive talk
and deeper learning.* Corwin.

Osterman, K., Furman, G., & Sernak, K. (2014). Action research in EdD programs in
https://doi.org/10.1177/1942775113498378

In P. N. Ololube & G. U. Nwiyi (Eds.), *Encyclopedia of institutional leadership,*
policy, and management: A handbook of research in honour of Professor Ozo-Mekuri Ndimele (pp. 1251–1265). Pearl Publishers International.


APPENDIX A

PARENTAL PERMISSION FORM

The Need to Improve Black Students’ Science Performance

Kirk Heath, University of South Carolina

**Purpose:** Your child is being asked to take part in a research project conducted Kirk Heath. The purpose of this research study is to solve a specific problem, challenge an existing paradigm, and address a critical barrier to progress in education. Specifically, the purpose of this concurrent mixed-method action research study is to improve Black students’ performance in my science class by improving their ability to use the claim, evidence, and reasoning (CER) framework. The intended result is to help Black students in my science class. Through an intentional focus on Black students’ CER skills, I anticipate gaining new knowledge to apply in my classroom and to share with my science department so my colleagues can better support their own students. Achieving the aims of this study would thus provide more equitable education for Black students in my school, aligning with the district’s mandate for Black excellence.

**Your Role:** Your child will be involved in four intervention lessons that will be taught by Kirk Heath between the month of August and September 2022 in the sixth-grade science classroom. Each lesson will last one hour, for a total of four hours over the course of the study. Kirk Heath will ask participants to complete an exit ticket at the end of each
lesson. Participants will also complete an online survey before and after intervention lessons. As the researcher, Kirk Heath will collect observation and artifact data. All questions will center on your child’s experiences using claim, evidence, and reasoning when working with peers.

**Notice of Confidentiality:** All information collected through this study will be held confidentially, meaning that Kirk Heath will not share any personally identifiable information about participants until data is de-identified. As a consequence of surveys, Kirk Heath will know the identities of students participating in the study. Participants will be assigned a personal identifier number or pseudonym, which will be used to link their responses during the study.

**Data protection and destruction plan:** The document linking student names and identifier numbers will be stored on a password-protected laptop.

The researcher may disclose your name or personally identifiable information or document, under the following circumstances:

- To those connected with the research,
- If required by Federal, State, or local laws,
- To comply with mandated reporting, such as a possible threat to harm yourself or others and reports of child abuse and neglect, or
- Under other circumstances with your consent.
I will do everything I can to keep your records a secret. It cannot be guaranteed. Both the records that identify you and the consent form signed by you may be looked at by others as follows.

- Federal agencies that monitor human subject research,
- Human Subject Research Committee, or
- Regulatory officials from the institution where the research is being conducted who want to make sure the research is safe.

Upon completion of the study, the data, or information collected during the study, will be destroyed.

**Voluntary Participation:** Participation in this study is completely voluntary. Choosing to withhold consent will not impact your child’s band grades or musical playing opportunities. You and/or your child can withdraw from the study at any time without any penalty.

**Risks and Benefits:** There is a chance that a data breach could occur, in which data from your child could be accessed by someone other than Kirk Heath. However, steps are being taken to protect collected data. The chances of such a breach are minimal. Your child will not benefit directly from participating in the study. However, I believe the results will help improve their education.

**Contact Information:** Please feel free to call the researcher, Kirk Heath, at XXX or XXX with any questions or concerns about participation in this study. You may also
contact Kirk Heath’s University of South Carolina advisor, Dr. Elizabeth Currin with any questions or concerns about your rights as a research participant at XXX.

Please mark below whether you agree to have your child participate in the study, sign the form, and return it to XXX.

☐ Yes, I agree to have my child and myself participate in this study.

☐ No, I do not give consent for my child or me to participate in this study.

______________________________________________________________  ________________________________________________________________
Parent Signature                                              Student Signature

______________________________________________________________  ________________________________________________________________
Parent Name (please print)                                    Student Name (please print)

Parents, please be aware that under the Protection of Pupil Rights Act, you have the right to review a copy of the questions asked within our study materials that will be used with your students (e.g., survey questions). If you would like to do so, please contact Kirk Heath at XXX or XXX to obtain a copy of the questions or materials.
APPENDIX B

PRE- AND POST-INTERVENTION TEST 1 AND 2

Test 1: Weather and Climate

SECTION A

Instructions: Questions 1 to 4 are multiple-choice based on the article “Weather and Climate.” Choose the most appropriate answer.

Weather or Climate?
By Cindy Grigg

1. What is the difference between climate and weather? The simple answer is "time."
2. Weather is what is happening in the atmosphere, the mixture of gases around the Earth, at a certain time and place. Weather changes constantly. Air masses move. Fronts form when two air masses of different temperatures with different moisture contents meet. Then the weather will change. Often a front brings thunderstorms. Warm air rises. Cooler air sinks. It rains. It's sunny. Weather changes from day to day or from hour to hour.
3. Climate is the average weather in a place over a long time. Weather data is recorded for a number of years. Climate is the average weather that has been recorded. Earth has many different climate zones. Tropical climate zones lie on either side of the equator. Polar zones are found near the North and the South Poles. Temperate climates are neither too hot nor too cold. Desert climates don't receive much rainfall. Climate change is a trend of change in climate averages of the past.
4. Many things affect the climate of a place. One thing is latitude. Latitude is a measure of the distance from the equator. Higher latitudes are closer to the North or South Pole. There, the sun's rays are less direct than at the equator. The sun's energy is spread out over a larger area. There the land and ocean don't get as much of the sun's heat, so they have lower temperatures. At the equator, the sun's rays are nearly at a right angle to Earth's surface. The sun's energy is concentrated. Land and ocean waters receive more heat than those near the poles.
5. Wind patterns affect the climate. If the wind starts out over water, it carries more water. If winds begin over land, the air mass is dryer. If the winds begin at high latitudes, the air masses are colder. Winds that start out in the tropics carry warmer air.
6. Mountains affect the climate of a place. Along the mountains of the western coast of the U.S., for one example, it is common to have lush green forests on the windward side. Moist air over the Pacific holds lots of water. The wind blows the moist air toward the mountains. The mountain is a barrier that pushes the air upward, and this causes it to cool. Cool air holds less moisture, so it rains on the side of the mountain facing the coast. The air that passes over the other side is dry. This is called the rain shadow effect. Because of this effect, deserts often are found on the leeward side (the side away from the wind) of mountains.
7. Ocean currents also shape the climate of a place. A current is a steady flow of water moving in one direction, like a river in the ocean. Warm ocean currents like the Jet Stream move heat from near the equator to the colder north. This makes the climate warmer along the coast of Great Britain, for instance. Currents in the ocean help distribute the uneven heat of the sun. Warmer water moves from the equator toward the poles. Cold water around the poles moves toward the equator.
8. Weather changes from day to day. Climate is the average weather over a number of years in a particular area. Different patterns of temperature and rainfall are found in different climates. Many different factors affect the climate of a certain place.
SECTION B

Instructions: Constructed-response questions in this section are based on the article “What Causes Climate?”

What Causes Climate?

Key Concepts
- What factors influence temperature?
- What factors influence precipitation?
- What causes the seasons?

Climate is the average, year-after-year conditions of temperature, precipitation, winds, and clouds in an area. The climate of a region is determined by two main factors: temperature and precipitation.
The same factors that affect climate regions also affect small areas. Microclimates are small areas with climate conditions that differ from those around them.
The main factors that influence temperature are latitude, altitude, distance from large bodies of water, and ocean currents. Earth’s surface is divided into three temperature zones. The tropical zone is the area near the equator, between about 23.5° north latitude and 23.5° south latitude. It has a warm climate because it receives direct sunlight all year. The polar zones extend from about 66.5° to 90° north and 66.5° to 90° south latitudes. They have cold climates because the sun strikes the ground at a lower angle. The temperate zones are between the tropical and polar zones—from about 23.5° to 66.5° north and 23.5° to 66.5° south latitudes. They have weather that ranges from warm in the summer to cold in the winter. Altitude is an important climate factor because air temperature decreases as altitude increases. Large bodies of water influence temperatures because water heats up and cools down more slowly than land. Marine climates have relatively warm winters and cool summers. Continental climates occur in inland areas and are often characterized by cold winters and warm or hot summers. Many marine climates are also influenced by ocean currents.
After reading the article, use the CER format to answer the questions “What factors influence temperature? What factors affect precipitation?”

Claim: The factors that influence temperature are…. The factors that affect precipitation are…..

Evidence 1: Based on the article, two pieces of evidence that support the claims are...

Evidence 2: Another piece of evidence that supports the claim is…

Evidence 3: The fourth piece of evidence to support the claim is….

Reasoning 1: The evidence supports the claim because….

Conclusion: Both pieces of evidence support the claim because …..this evidence is related to …..
The Gulf Stream: A Current That Helped Win a War

Can you believe that an ocean current may have helped the United States become the United States? Before the Revolutionary War, Benjamin Franklin—you may know him as one of the founders of our country—and his cousin mapped a strong current called the Gulf Stream, which flows north along the East Coast of the United States. Understanding where the Gulf Stream flows was helpful for sailors coming and going from East Coast ports because ships that sailed in the same direction as the Gulf Stream, or cut straight across it, could go faster than ships that tried to sail against it. Some people have even claimed that this knowledge of the Gulf Stream might have helped America win the Revolutionary War, because American ships were able to travel around the area more quickly than British ships.

The Gulf Stream still flows today, and it still affects how goods are shipped around the world. The Gulf Stream forms near the tip of Florida and flows north, carrying warm water from the Caribbean up the east coast of North America and across the North Atlantic. This large, strong current carries more than 100 million cubic meters of water per second, more than all the world’s rivers combined.

What causes the Gulf Stream current to flow, and what determines its route? The strength and direction of the Gulf Stream are driven partly by prevailing winds—winds that always blow in the same direction and are strong enough to push ocean water around. Prevailing winds near the equator blow from east to west across the ocean. Prevailing winds farther north and south blow in the opposite direction: they go from west to east. Another factor that affects the direction of the Gulf Stream and other ocean currents is the location of the continents.
1. According to the article, The Gulf Stream begins when…
   A. warm water near the equator is pushed west across the Atlantic Ocean by the prevailing winds.
   B. cold water near the equator is pushed east across the Indian Ocean by the prevailing winds.
   C. warm water near the equator is pushed west across the Indian Ocean by the prevailing winds.
   D. All the above answers are correct.
2. The Gulf Stream warms up the air wherever it goes. This means that:
   A. The Gulf Stream flows from east to west.
   B. The warm water carried from the equator contains a lot of energy, which transfers to the cooler air above it, bringing warm air temperatures to the East Coast of North America and making Western Europe warmer than other places at similar latitudes.
   C. The Gulf Stream is one of the most important surface ocean currents in the world. It’s very strong and covers a long distance.
   D. Both A and B are correct.

3. The strength and direction of the Gulf Stream are driven partly by:
   A. prevailing winds near the equator that blow from west to east across the ocean.
   B. prevailing winds that always blow in the same direction and are strong enough to push ocean water around.
   C. prevailing winds farther north and south blow in the same direction.
   D. None of the above answers are correct.

4. When the Gulf Stream reaches New England,
   A. the prevailing winds moving from west to east blow the Gulf Stream away from the coast of North America and across the northern Atlantic.
   B. the prevailing winds moving from west to east blow the Gulf Stream toward the coast of South America and across the eastern Atlantic.
   C. the Gulf Stream starts off the coast of Florida, where the prevailing winds blow the water west toward Florida, in the same direction as the wind.
   D. Both A and C are correct.

SECTION B

Prompt: Surface currents in the ocean are driven by global wind systems that are fueled by energy from the sun. Patterns of surface currents are determined by wind direction, Coriolis forces from the Earth’s rotation, and the position of landforms that interact with the currents. The table below shows data for ocean currents from several places around the world.
Question: Does the flow direction relative to the equator affect the temperature of the ocean currents in a Western location?

Claim:

Evidence 1: Based on the above article, two pieces of evidence that supports the claim are...

Evidence 2: Another piece of evidence that supports the claim is…

Evidence 3: The fourth piece of evidence to support the claim is…

Reasoning 1: The evidence supports the claim because…

Conclusion: Both pieces of evidence support the claim because …..this evidence is related to ….
APPENDIX C
SURVEY QUESTIONS

Section A:
1. Tell me about a time when something you learned in science class had a positive impact on your grades.
2. Tell me about a typical day in science class.

Section B:
1. How do CER strategies help you in science class?
2. Could you share an example of how learning CER strategies helped you earn better grades in science class?
3. Could you explain what part of CER you benefit from the most in science class?

Section C:
1. How does working with peers help you use CER strategies to learn science content?
2. How does working with peers contribute to improving your science performance?
3. How important is it to learn claim, evidence, and reasoning as a Black science student? Please use the Likert Scale below to select how important it is to learn claim, evidence, and reasoning as a Black science student.

Likert Scale
1. Not at all very important
2. Somewhat important
3. Uncertain/Uncertain
4. Important
5. Very important
Overarching Question: What happens when I take a more social constructivist approach in my science classroom?

**Research Question 1:** How does adapting my approach impact my Black students’ grades?

**Research Question 2:** How does adapting my approach impact my Black students’ attitudes?

**Research Question 3:** How does adapting my approach impact my Black students’ behavior?

Date of Observation: ______________ Period: 1 Black/Red, 2 Black/Red, 3 Black/Red

Participants: Black sixth-grade science students

<table>
<thead>
<tr>
<th>Descriptive Field Notes</th>
<th>Reflective Field Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Child_____________ Grade______________ Date________________

1. Describe your experience working with partner today.

2. How do you feel about using the claim, evidence, and reasoning framework?

3. Things I found interesting during today’s class:

4. Questions I still have: