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Classroom Influences on Third Grade African American Learners' Mathematics Identities

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CLASSROOM INFLUENCES ON THIRD GRADE AFRICAN AMERICAN LEARNERS' MATHEMATICS IDENTITIES

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Education
at the University of Kentucky

By

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Lexington, KY

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ABSTRACT OF DISSERTATION

CLASSROOM INFLUENCES ON THIRD GRADE AFRICAN AMERICAN LEARNERS' MATHEMATICS IDENTITIES

Students' mathematics identity has become a more prominent concept in the research literature (Jackson & Wilson, 2012). The experiences of African Americans are still underreported, with African American elementary students receiving the least attention. This dissertation uses a case study method to explore two learners' experiences. The purpose of this qualitative study was to explore African American third grade students' classroom interactions with mathematics in order to better understand factors that promote positive mathematics identities.

This research study explored the mathematics classroom influences on two third grade African American learners' mathematics identities in a K-8 school in a north central Midwestern city in the United States. The school was classified as 100% free and reduced lunch and served approximately 900 students, with the vast majority of students classified as African American. The three student participants and their teacher were all African American. The student participants wore glasses that video recorded their perspectives. A stationary camera was also used to capture the wider classroom environment. Each student participant completed three interviews (Seidman, 2013). The teacher participant completed one interview. Additionally, the student participants completed a mathematics interest questionnaire.

Findings showed the importance of an explicit focus on the Standards for Mathematical Practice, a growth mindset, and positioning for promoting positive mathematics identities. In one case study, Janae's experiences in lessons about fractions highlight the relevance of the Standards for Mathematical Practice, specifically *attending to precision* and *making sense of and persevering in solving problems*. In both the classroom and in interviews, she shows the importance of making sense of problems and persevering in solving them and of attending to precision. In the second manuscript, I explore Janae and Kayla's different experiences. Janae was positioned more positively and faces limited resistance in maintaining a positive mathematics identity. Kayla, on the other hand, regularly rejected and renegotiated the positions offered to her as she aimed for success and a positive mathematics identity. Kayla's growth mindset and negotiation of positions offered to her in the classroom were critical factors in how she maintained a positive mathematics identity.

KEYWORDS: Mathematics Identity, Standards for Mathematical Practice, Positionality, Growth Mindset, Urban Education

______Oliver Thomas Wade Roberts_____

____________April 18, 2017___________

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Chapter 1

Introduction

The National Council of Teachers of Mathematics' (NCTM) publication of *Curriculum and Evaluation Standards for School Mathematics* in 1989 forms the basis of the *Mathematics for All* movement (Martin, 2003). In this publication, NCTM (1989) references past social injustices and the inequitable distribution of mathematical literacy, with women and racial minorities, as problems that must be addressed out of "economic necessity" (p. x). While the authors note the broad need to increase mathematical literacy in the population at large, no time is given to explain how teachers, policy makers, or the public could work to achieve this goal.

In 2000, NCTM published *Principles and Standards for School Mathematics*. Among the six principles for school mathematics, the equity principle, while listed first, is too broad to be of much guidance. NCTM (2000) argued, "excellence in mathematics education requires equity—high expectations and strong support for all students" (p. 12). While this provides more guidance than the *Curriculum and Evaluation Standards for School Mathematics*, it also creates a simplified vision of how to achieve equity in mathematics. Simply implementing high expectations and providing strong support still was not specific enough to be actionable in the classroom. Moreover, the *Mathematics for All* rhetoric within does nothing to distinguish between historically marginalized groups.

In 2014, NCTM published *Principles to Actions*. The authors of this report highlight three constant difficulties in the *Mathematics for All* goal: continuing achievement gaps, especially in terms of race, ethnicity, and socioeconomic status;

continuing disparities in levels of mathematics learning; and continuing underrepresentation of females and minorities who are interested in STEM fields. These difficulties help perpetuate the “gap-gazing fetish” (Gutierrez, 2008), in which researchers study the achievement gap in terms of racial comparisons without questioning the causes of the gap. Even so, this most recent document begins to delve more deeply—although still in a racially and ethnically bland manner—into actions to overcome the obstacles.

The primary obstacles to achieving the Access and Equity Principle include lower quality instruction for poor and struggling mathematics students; an overemphasis on procedural knowledge, lower expectations, limited options for some students to take more advanced mathematics (i.e., tracking); and, perhaps due to the prior obstacles, an all too common lack of confidence in students’ mathematics abilities (NCTM, 2014). While these obstacles continue to be broad and not targeted to the benefit of any one group, the authors do break with their predecessors by offering actionable recommendations to overcome these obstacles. Specifically, the authors focus on the importance of teachers having productive beliefs about all students’ abilities to learn and do mathematics; of providing opportunities for all students to access challenging curriculum with the support of excellent instruction; and of targeted differentiation to support student success at all levels.

All of the aforementioned strategies, while relevant at the school building level, are also directly tied the classroom. However, they remain racially neutral, not taking into account mathematics learning as a form of racialized experience (Martin, 2006). The NCTM documents also prioritize the teaching and curriculum areas while marginalizing student experiences in the mathematics classroom. With these ideas in mind, I purposefully chose to examine African Americans students' experiences in the third grade mathematics classroom.

Problem Statement

While the so called gaps in mathematics performance between different racial groups have received more than their fair share of attention (Gutierrez, 2008), less attention has been given to how traditionally underrepresented populations begin to identify with mathematics (Jackson & Wilson, 2012). Martin (2000) explored how African American students form mathematics identities in the mathematics classroom. From his work, Martin conceptualized four distinct factors that influence African American identity development: sociohistoric influences, community and parent influences, school level influences, and individual influences.

The sociohistorical influences focus on historically discriminatory practices and procedures that prevented African Americans from becoming full participants in many areas of society, including mathematics. Parental and community influences include messages about the importance or non-importance of mathematics, which children internalize. The impacts, both positive and negative, have been highlighted in several studies. For example, Howard (2003) focused on academic identities of African American high school students and noted parents and parental expectations as one of the largest influences on students' identities. Terry and McGee (2012) found African American high school males often credit their families' expectations and advocacy as important factors for their success in mathematics. On the other hand, African Americans have historically been marginalized and excluded in the mathematics classroom. Thus, many African American parents experienced mathematics as a gatekeeper, with teachers usually being those who excluded them from mathematics. One student in Howard's (2003) study on African American students' academic identities referred to the experience as a chance "to get profiled for 'learning while Black'" (p. 11).

Experiences like these highlight the importance of the school level. This level focuses on the norms of the school and classroom, the teacher's beliefs and instructional practices, and the curriculum (Martin, 2000). While these particular items were identified nearly twenty years ago, there is still limited work in how they impact African American learners' mathematics identities. Moreover, with research consistently highlighting teaching quality as the most important school factor in student achievement (Sanders, Wright, & Horn, 1997; Hanushek, Kain, Markman, & Rivkin, 2000; Rowan, Correnti, & Miller, 2002), there has been limited work focusing specifically on elementary African American students' experiences in the one area where teachers have the most control, their classrooms. Thus, it is important to explore African American elementary students' classroom experiences with a particular focus on how they develop their mathematics identities based on these classroom experiences.

Purpose and Research Questions

Many African American learners continue to experience mathematics as a gatekeeper subject (Aguirre, Mayfield-Ingram, & Martin, 2013) and there continues to be an underrepresentation of African American learners' experiences in the mathematics classroom. The purpose of this qualitative study was to explore African American third grade students' classroom interactions with mathematics in order to better understand factors that promote positive mathematics identities. With the understanding that teaching and learning are complex processes, multiple observations and discussions occurred to examine student experiences in the mathematics classroom over several lessons. Moreover, being cognizant of the differential power structures at play (Punch, 2002) and of children's potential to exaggerate to please the researcher due to the power differential (Hopkins, 2013), I used multiple sources of evidence (i.e., student interviews, teacher interview, video, and field notes) when analyzing students' experiences.

The research question for this study is:

- How do third grade African American students generate mathematics identities from their experiences in the figured world of the mathematics classroom?

Significance of the Study

Studies focusing on mathematics identity usually analyze students, preservice teachers, inservice teachers, and/or teacher educators (Groontenboer, Smith, & Lowrie, 2006). Researchers have studied various stages of mathematics identity in teachers. For example, Schuck (1996) reported prospective primary teachers have a fixed mindset about mathematics, often saying mathematics was reserved for smart students and not for them. Grootenboer and Ballantyne (2010) conceptualized teachers' mathematics identities as being on a continuum from teacher to mathematician with most inservice teachers identifying as a mathematics teacher first. The teachers did not identify as mathematicians primarily because of their views of mathematicians as aloof and formulaic.

Mathematics identity has been more prominent in researching students. Jackson and Wilson (2012) credit Martin's (2000) study as the beginning of the focus on successful experiences of African Americans in mathematics. As of their 2012 review, only 13 studies focused specifically on successful African American experiences in mathematics. The limited number of studies of successful African American experiences in the classroom is one reason this study is significant.

Of the studies that do examine African American identities, none focus explicitly on African Americans in the elementary classroom. Berry (2003) explored academically successful African American males in middle school. Later, Berry, Thunder, and McLain (2011) focused specifically on mathematics identities of middle school males. Martin's (2000) work was focused on African American junior high students and adult learners. Other studies have explored mathematics identity more broadly. For example, Boaler and Greeno (2000) found AP Calculus students in high school who experienced mathematics in ways that did not oppose their personal identities were more likely to enjoy the subject and plan on continuing their study of mathematics. Hodge (2008) is the only study that followed elementary students to examine the development of their mathematics identity. In that study, Hodge explored how predominantly White students in an affluent district developed mathematics identities as they experienced first and second grades with teachers who implemented different pedagogy. Thus, the unique perspectives presented in this study contribute to the limited literature highlighting this population's experiences.

Finally, this study attempts to prioritize student voice through their experiences. Research on children often views children in one of four ways: child as object, child as subject, child as social actor, and child as participant/co-researcher (Christensen & Prout, 2002). The dominant view is child as object, which explains why most of the literature ignores the rights children have as participants and instead focuses on procedural ethics. Procedural ethics are the formalities in conducting research, such as obtaining approval from an Institutional Review Board, addressing issues of basic rights and safety issues, and of seeking consent and assent. As described more in the method section, I purposefully used stimulated recall interviews in a similar way as Zavala (2014), to explore specific classroom experiences through the explanation of the children who experienced it. Furthermore, as Nieto (1992) explains:

> The experiences of students from disempowered and dominated communities are usually even more invisible. Case studies provide an important vehicle for these voices... The purpose of case studies is not to generalize to all students... It is important to underscore that no case study of a single individual can adequately or legitimately portray the complexity of an entire group of people... Rather it is important to understand each of the case studies as one example of the ethnic experience within the United States rather than as the model by which all students of a particular group should be understood. (pp. 11-14)

Thus, I made a cognizant effort throughout the research design, data collection, and data analysis to incorporate student voice. That effort also makes a significant contribution to the literature.

Theoretical Framework

Figured worlds focuses on how people participate in socially and culturally constructed contexts (Holland, Lachiotte, Skinner, & Cain, 1998). This theory is largely based upon the work of Vygotsky and Bakhtin (Holland et al., 1998; Urrieta, 2007). Vygotsky emphasized individual development through social interactions. When applied to a learning situation, this leads to the zone of proximal development, an area one is cognitively ready to explore, but needs the help and social interaction of a more experienced other to support emerging understandings (Vygotsky, 1978). Symbols mediate the social interactions and impact self-formation. When interacting in a specific context (i.e., a third grade mathematics classroom), symbols help organize individuals' activities (Penuel & Wertsch, 1995). Using the symbols and artifacts to organize themselves allows individuals to impart meanings onto themselves and onto their interactions with others (Penuel & Wertsch, 1995).

Bakhtin (1981) contributed ideas related to authoring and dialogism. In short, Bakhtin (1981) argued the world must be answered. In this view, thoughts occur because of or in anticipation of social interaction. One can then produce meaning through dialogue (Holland et al., 1998). Dialogism also suggests people can hold contrasting thoughts at the same time (Bakhtin, 1981). Instead of one idea gaining an ongoing advantage, the dialogic process allows various ways of authoring to exist, with ideas gaining and losing advantage depending on the context. Thus, how one authors identity in a given context depends on the interactions with others in a given context (Holland et al., 1998).

Based on these theories, identities are produced over time, through interactions, and within a specific place (Holland et al., 1998). These specific places are called figured worlds. How individuals perceive the figured worlds can impact the figured worlds and the identities individuals create and recreate. Moreover, the ways individuals interact within the figured worlds are partly due to their experiences in other figured worlds, partly independent of these experiences, and due to outside forces (Holland et al., 1998). Thus, because each individual enters figured worlds with different experiences and experiences the figured worlds differently, identity development in figured worlds emphasizes the interactions within the figured world (Urrieta, 2007).

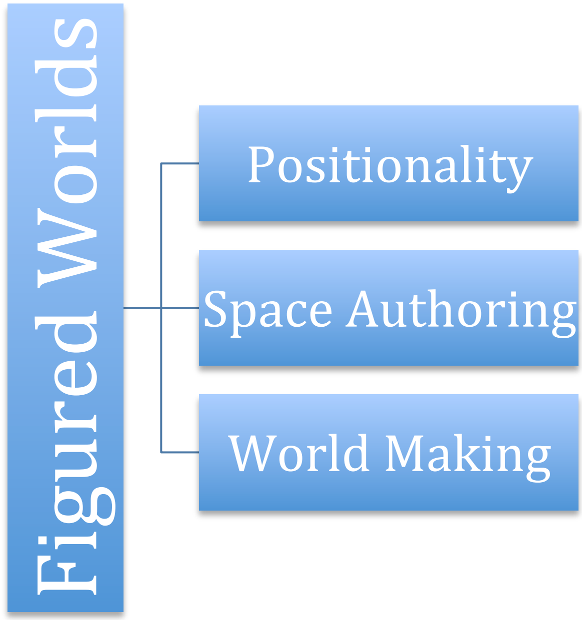


Figure 1.1. Figured worlds framework

As shown in Figure 1.1, three contexts are important for identity formation in figured worlds: positionality, spaces for authoring, and world making (Holland et al., 1998). Positionality focuses on issues of power, privilege, and how an individual views oneself in relation to belonging in the figured world. In a classroom, such positions could be good student, class clown, or talkative student, for example. Issues of power and culture influence positionality. Social categories (i.e., gender, class, and race) of individuals in figured worlds can create opportunities or barriers. How the social categories, relationships with others, individual actions, and cultural resources interact within the figured world impacts the positions offered to members of the figured world. Individuals must accept, reject, or negotiate the identities being offered to them in the figured world (Holland et al., 1998).

Positionality is related closely to Bourdieu's habitus (Holland et al., 1998). Habitus refers to habits, skills, and dispositions individuals develop during their life and under the influence of class, race, gender, and culture, as some examples (Bourdieu, 1977). Important in habitus is it is not context dependent, but instead remains constant. While habitus can evolve as individuals have new experiences (i.e., through education or travel), the new habits, skills, and dispositions remain related to dominant institutions of power. Holland et al. (1998) relate the idea of "history-in-person" (p. 18) to habitus. History-in-person refers to the experiences an individual has from being in or having been in multiple figured worlds. These experiences help shape how a person responds when offered a position in a figured world (Holland et al., 1998).

Space of authoring is based on Bakhtin's dialogism. Individuals can hold contrasting views at the same time, with one view becoming more dominant in a given context (Bakhtin, 1981). The contrasting ideas individuals concurrently hold help shape their responses to the positions they are offered in a figured world. Holland et al. (1998) argued while novices in the figured world may accept the position offered by a more powerful figure, a more seasoned person might take the opportunity to shape worlds differently. For example, a new student who speaks out of turn in class may accept the teacher given label of talkative student. However, a more seasoned student positioned as class clown by the teacher may renegotiate the identity to popular student based on his ability to make his peers laugh. How the individual decides to respond is a choice: accept, reject or negotiate; however, deciding not to respond is also considered a response (Urrieta, 2007).

For the purposes of this study, the third grade mathematics classroom is the figured world. How students generate their identities in that figured world depend upon the positions they are offered, the positions they claim, and any negotiation they do to align the positions they are offered and the positions they claim. Thus, some students may have limited negotiation while others require significant negotiation of positions. For example, a student who never received good grades in mathematics classes and who rarely had positive interactions with mathematics teachers but suddenly begins receiving support from a mathematics teacher and earning good grades may have to negotiate competing positions. This hypothetical student entered the class with a negative mathematics identity due to accumulated negative positions. The new positions that countered the previously established ones would have to be negotiated to determine if this student maintained a negative mathematics identity or began to change to have a more positive mathematics identity. In this study, the positions students possess and the positions students are offered require negotiation when in conflict. How they reconcile these varied positions and the ultimate positions they claim are how they go about generating their mathematics identities.

The Researcher

As the researcher, my experiences and beliefs are important to acknowledge and address before presenting my method, findings, or discussions. As a White male from a middle class background, my experiences vary dramatically from the participants in my study. I have not experienced mathematics as a racialized experience, as Martin (2006) described it, in the same way the participants in this study have. I have not experienced mathematics as a gatekeeper (Aguirre et al., 2013). Moreover, I have not experienced the same sociohistoric effects of systematic discrimination and of generational poverty the participants in this study.

What I have experienced is a teaching career dedicated to providing high quality instruction in underserved schools. All my teaching experience at the primary level (Pre-Kindergarten through Eighth Grade) has been in urban settings, ranging from Florida to North Carolina to Michigan. Throughout these experiences, I have developed several beliefs about the students I serve. The students I worked with have entered my classroom ready to learn. They have their own unique experiences that are often different from mine, yet no less valuable to use within the classroom. The students are inquisitive. They are creative in solving problems. Their parents want what is best for them. Moreover, I have come to realize that one assessment does not reflect their abilities, nor does it measure the breadth of their understandings. As a resource teacher at the school where this study occurred, these statements apply just as much to the participants in this study as to any other student with whom I have worked.

Working in urban schools has also led me to develop ideas about teaching. The classrooms where I see students learning the most are those that engage students in active learning. Where I have worked, mathematics classrooms that provide students relevant problems that invite them to collaborate and use multiple strategies lead to deeper understandings. This partly explains my tendency to view learning through a social constructivist (Vygotsky, 1978) lens. These quality problems are only part of the equation, though. Teachers also have to bring a desire to incorporate their students' backgrounds into the classroom. When the classroom becomes a shared space, deeper learning occurs. My experiences shaped my beliefs. These beliefs cannot be wholly separated from this study. Thus, I have addressed them in the beginning.

For this particular study, it is also important to note I served as the STEM teacher at the school where this study was conducted. Thus, in addition to power differentials due to race and gender, I was employed in a position of power relative to the participants. Thus, there are ethical issues of power (Matthews, 2001). For example, the student participants of the study knew me as a teacher in the building. As such, I had an additional layer of authority in their school experiences. Moreover, they knew I worked closely with their mathematics teacher. Thus, there was a possibility that they would be hesistant to answer questions honestly. To mitigate these issues, I repeatedly emphasized that I would not share their thoughts with their teacher. I also took care to interview the student participants away from their mathematics classroom and from other teachers to create physical distance for them to speak freely. I also attempted to remain cognizant of ethical symmetry, described as "the view that the ethical relationship between researcher and informant is the same whether he or she conducts research with adults or with children" (Christensen & Prout, 2002, p. 482). In doing so, I attempted to make sure the questions I asked and the data I collected were done in a child friendly manner. For example, I worked hard to incorporate student friendly language in our semi-structured interviews. As I interviewed student participants, if common vocabulary came up, I incorporated that into my conversations with other participants so that "the practices employed in [my] research [were] in line with children's experiences" (Christensen & Prout, 2002, p. 482). Accordingly, when I incorporated student participants' language into our conversations, the conversations became more rich in content.

My positionality not only impacted my interactions with the participants. It also impacted other parts of the study. In creating the research question, my experiences as a teacher in urban schools led me to think about how students identify with STEM subjects broadly, and mathematics in particular. Knowing how important teachers are to students, I was curious to see how students' classroom experiences influenced their relationship with mathematics. When thinking about data collection, I wanted a wide variety of data sources. While standardized tests are important in schools, I did not want to rely on them for two primary reasons. First, I do not think standardized assessments accurately reflect students' abilities. Second, third grade students take them at the end of the year. As such, I had no standardized assessments on which to judge the student participants. Moreover, I did not have access to standardized assessments for this class of students. Instead of relying on assessments, I chose to rely on the student participants' previous performance according to report cards. Other than that, I cared more about their current experiences instead of outdated reports of their achievement. That is why I decided to use the individual glasses in addition to the stationary camera.

As a teacher in the school, I had not taught the student participants when the study began. However, I was a known quantity. I was able to build a relationship quicker because of my position within the school. As they developed a trust with me outside of the research focus, the participants carried that trust into the research process, too. I believe this led to a more open and honest conversation around their experiences in the classroom, both positive and negative. I completed the first two rounds of interviews before they attended the STEM Lab special. Not knowing the students before beginning data collection and analysis helped me focus on bigger ideas, instead of personalities. As I taught them, I noticed ways in which they acted similarly and differently between their mathematics class and STEM class. These observations, while informal, cannot be ignored as they informed my analysis, particularly of Kayla's actions in the classroom.

Limitations

My goal in this study was to examine the lived experiences of African American learners in the third grade classroom. Through their experiences, I was interested in exploring how they developed mathematics identities. While I made an attempt to thoughtfully and thoroughly document their experiences, there are several limitations. One research design limitation was the small number of participants. I attempted to learn about the experiences of four third graders. Three assented and their parents consented to participate. More participants would have strengthened the study as more students' experiences could be explored. Although generalizability was never a goal of this design, more participants would have allowed for a deeper examination of larger issues within this particular classroom. The fewer participants did let me focus more deeply on each individual's classroom experiences in this particular study.

Relatedly, while the observations and interviews took place over the span of ten weeks, the videos and observations only capture a few days of instruction. Due to limitations in time and resources, I was unable to observe for prolonged periods of time and rarely could observe for consecutive days. Much of this was out of my control due to the testing schedule around which this study occurred. Relatedly, there is a possibility that "camera days" could create a slightly altered version of normal classroom days. After reviewing the videos, I do not think this was a major limitation but did think it worth acknowledging. Moreover, my ongoing interaction with the student participants and their entire class reinforce this belief as their overall behavior and interactions were consistent between "camera days" and non-videoed days.

Finally, focusing the study to one grade in one school is a limitation. The ability to transfer the findings of this study would be strengthened if I had the opportunity to conduct the study among several grades, with different teachers, in different schools, and in different locations other than the Midwestern United States. While this is a minor limitation, it also worked in my favor as being a part of the school community where the study occurred helped me forge stronger relationships with the participants in the study. As I questioned student participants about classroom practices, I think this is a significant strength as I was able to establish a trusting relationship to allow them to freely discuss the positive and negative experiences they faced in another teacher's classroom.

Definitions

There are several terms I use to discuss participants in the study. For example, teacher refers to the third grade mathematics teacher whose pseudonym is Ms. Madison. I also use the term student to refer to participants and their peers in the mathematics classrooms. The student participants themselves have been given pseudonyms, Janae and Kayla. In addition to these terms, the following list shares how I operationalized significant terms throughout the study.

African American: intended to include anyone having origins in the Black racial groups of Africa or origins in the Caribbean, Central America, South America (Museus, Palmer, Davis, Maramba, 2011); it is important to acknowledge that some individuals prefer to identify as either African American or Black.

Ethical Symmetry: “the view that the ethical relationship between researcher and informant is the same whether he or she conducts research with adults or with children” (Christensen & Prout, 2002, p. 482).

Figured World: a socially and culturally constructed space in which individuals are recognized, specific actions communicate significance, and specific outcomes are prioritized (Holland et al., 1998)

Growth Mindset in Mathematics: the belief that mathematics understanding can happen through hard work, perseverance, and help from others (Dweck, 2008; Boaler, 2016)

Mathematics Identity: the beliefs individuals possess about their ability in mathematics, the importance of mathematics, and their desire to pursue mathematics (Martin, 2000)

Mathematical Literacy: ability to use and understand numbers in the context of problem solving

Mathematical Proficiency: the knowledge, skills, and mindsets needed to be successful in mathematics; Composed of conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (National Research Council, 2001)

Reformed Mathematics: the practice of “doing” mathematics through problem solving to develop procedural and conceptual understanding of interconnected mathematical ideas

Position: specific titles that result from positions negotiated within a figured world (i.e., smart student, troublemaker, or class clown)

Positionality: theoretical concept that focuses attention on issues of power, privilege, and how an individual and others views one in relation to belonging in the figured world (Holland et al., 1998)

Standards for Mathematical Practice: process standards that focus on specific practices that, along with content standards, help lead to mathematical proficiency.

Traditional Mathematics: the practice of mathematics as a set of unconnected rules and procedures with an emphasis on memorization and drill

Organization of Dissertation

This dissertation contains five chapters. Chapter One provided an introduction to young African American learners' mathematics identity development while explaining the need for this study. A purpose for the research was established. The research question and discipline specific terms have been described. Chapter Two will review relevant literature for this study. In that chapter, I provide an overview of how children learn mathematics, of how African American students have been situated in mathematics classrooms, of mathematics identities with a specific focus on African American mathematics identities, and on growth mindsets in the mathematics classrooms.

Chapter Three will provide the overall methodology used in this research study. Chapters Four will present findings of this study in the form of two manuscripts. This first manuscript presents a case study that examines the connection of the Standards for Mathematical Practice, content, and Janae's mathematics identity development. The second manuscript explores Kayla's and Janae's drastically different experiences in the same mathematics classroom and the factors that influenced their mathematics identities. Chapter Five concludes this dissertation with a discussion of the significance of the overall findings and implications for future research.

Chapter 2

Review of the Literature

Several categories of research literature informed this study: instructional trends in the mathematics classroom; how students come to learn mathematics; how African Americans have been situated in the mathematics classroom; how African Americans are taught in relation to how they learn mathematics; and mathematics identity. The first section of this chapter describes instructional trends in the mathematics classroom in the United States from the early twentieth century to the present. The next section presents the research related to how children learn mathematics. This section focuses on mathematical proficiency as the goal of learning mathematics. The third section provides a comprehensive overview of how African Americans have been situated in education and the mathematics classroom. It provides context related to the lingering sociohistoric effects African Americans continue to experience that shape their mathematics identities. The fourth section describes African American students' learning preferences and the teaching styles they experience. This section is important in providing context for what is often a disparate learning environment in terms of meeting students' needs. The final section focuses specifically on mathematics identity with an emphasis on African American mathematics identity development. Together these areas provide context for this study by addressing multiple factors important to learning in the mathematics classroom.

Instructional Trends

There were six phases of mathematics education in the United States during the twentieth century (Lambdin & Walcott, 2007). Each phase (see Table 2.1) aligned with prevalent theories of learning. Moreover, each phase not only has implications for classroom practices, but also for shaping ideas about how students come to learn mathematics.

Table 2.1

Six Phases of 20th Century Mathematics Education in the U.S. Modified from Lambdin and Walcott (2007)

Phase	Time Period	Theory	Learning
Drill	1920-1930	Connectionism	Memorization and step-by-step procedures
Meaningful Math	1930-1950s	Gestalt	Incidental learning and mathematical relationships
New math	1960-1970s	Developmental psychology & Sociocultural	Structure of mathematics, discovery learning
Back to basics	1970s	Connectionism	Drill and practice
Problem Solving	1980s	Constructivism	Discovery learning, problem solving
Standards & Accountability	1990s-present	Constructivism with influences from previous phases	Combination of drill, problem solving, real world solutions, structure of mathematics

The first phase begins in the 1920s and focuses on Edward Thorndike’s connectionism or S-R bond theory. Thorndike argued students learn through conditioning, in which “specific responses are linked with specific stimuli” (Lambdin & Walcott, 2007, p. 4). The primary focus in this phase was on building students’ abilities to compute through rote memorization. For teachers, this theory emphasized using drill and practice, breaking mathematics into a series of step-by-step procedures, and discouraging originality.

As society began coping with the Great Depression, there was a shift in thinking of how students learn mathematics. Many thought Thorndike’s theory was overused (Birdwell & Clason, 1970). For example, Knight (1970) explained in the introduction of the 1930 yearbook for the National Society for the Study of Education, “in the older school there was an overconfidence in drill—too often so stupidly administered that it could not possibly effect learning—and a corresponding neglect of interest and of the significance of the work to the worker” (p. 483). Thus, the second phase emphasized meaningful learning of mathematics (Lambdin & Walcott, 2007). What exactly meaningful learning was varied. Some encouraged practical, activity approaches to learning. Others advocated for learning through experiences rather than by a systematic program of instruction. This idea of incidental learning advocated for learning through context; however, critics suggested this led to fragmented understandings and disjointed learning (Lambdin & Walcott, 2007).

Others argued for meaningful learning in a different way. For instance, Brownell’s meaning theory valued student experiences, but emphasized making meaning by mathematical relationships (Kilpatrick, 1992). This coincided with the introduction of Gestalt theory to mathematics education in the United States. Gestalt theory focused on discovery and gaining insight as important factors of learning (Birdwell & Clason, 1970). In the classroom, teachers focused on activities to help students see how different concepts were related to each other and to the real world (Lambdin & Walcott, 2007).

As World War II ended and the Soviet Union launched *Sputnik*, mathematics was again the focus of reform (Kilpatrick, 1992; Lambdin & Walcott, 2007). As Kilpatrick (1992) explains, the effort to reform came from diverse groups:

> American schools were under attack from business and the military for graduating young adults who lacked basic computational skills, from colleges for failing to equip their entrants with a knowledge of mathematics adequate for college work,

and from the public... for having watered down the curriculum in response to progressivism and life-adjustment education. (p. 24)

These calls brought about the third phase, new math.

One of the major changes in new math was the emphasis on understanding the structures of mathematics and introducing these ideas, such as set and number theory, earlier in the curriculum (Lambdin & Walcott, 2007). Jerome Bruner advocated two primary ideas in this phase, spiral curriculum and discovery learning. Spiral curriculum repeatedly returns to the same concepts with increased difficulty. This reflects Bruner's Piaget-based theory that students have three stages (manipulative, visual, and abstract) of representation in their learning. Discovery learning emphasized students discovering ideas and connecting the new ideas to known ideas. This also supports the idea of spiraling curriculum as students are expected to connect what they have learned to their new, more complex discoveries in the structure of mathematics (Lambdin & Walcott, 2007).

These significant changes led to skepticism in terms of the content and the utility of what was being learned and in terms of practice in the mathematics classroom; consequently, the fourth phases was ushered in during the 1970s as an effort to get back to the basics (Lambdin & Walcott, 2007). During this phase, no new learning theories informed instruction. Instead, connectionism regained prominence with the emphasis on drill and step-by-step procedures. This phase was short lived due to a renewed fear of international (in)adequacy emphasized in the 1980s.

The fifth phase emphasized problem solving. This phase began with teachers teaching students how to solve problems, but evolved to teaching through problem solving by using engaging activities that required students to work collaboratively and explain their processes and reasoning (Lambdin & Walcott, 2007). These teaching strategies aligned with constructivist learning theory (Vygotsky, 1978), as both emphasize the importance of students actively working to make sense of problems through their own strategies.

These five phases informed the sixth phase, standards and accountability. Lambdin and Walcott (2007) pinpoint the publication of NCTM's *Curriculum and Evaluation Standards for School Mathematics* in 1989 as the beginning of this phase. This document—and those that followed it—focused on content and constructivist theories of how students learn. As a result, the National Science Foundation funded curricula to align with the standards and states began adopting formal content standards (Lambdin & Walcott, 2007). The National Research Council (2001) describes this phase as being focused on mathematical power. Mathematical power goes beyond the ability to compute to emphasize problem solving, reasoning, making connections, and communicating ideas (NRC, 2001). The federal government increased accountability for teaching and learning through assessments as the standards were implemented and as fears of international inadequacy remained (Lambdin & Walcott, 2007).

While all of this change was occurring in the 1990s, the "math wars" also began. In explaining their historical context, Schoenfeld (2004) sums up the math wars as follows: "Traditionalists fear that reform-oriented, 'standards-based' curricula are superficial and undermine classical mathematical values; reformers claim that such curricula reflect a deeper, richer view of mathematics than the traditional curriculum" (p. 253). This tension helps explain what Lambdin and Walcott (2007) described visitors would see in today's mathematics classrooms, "evidence of most of the major phases through which mathematics education passed during the twentieth century" (p. 20). These influences are represented in the "Learning" column of Table 2.1 for the Standards & Accountability phase.

How Students Learn Mathematics

The increase in accountability led to an increase in demand for research on how students learn mathematics. In 1998, the United States Department of Education and the National Science Foundation formed the Committee on Mathematics Learning to synthesize the research literature on mathematics learning from pre-kindergarten to eighth grade (National Research Council, 2001). In their report, the Committee described successful mathematics learning with the term mathematical proficiency, which is composed of the five interwoven strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (NRC, 2001). These strands not only describe the knowledge and skills needed for mathematical proficiency, but also the mindsets. The focus here is not on memorizing, but on understanding the content. What exactly understand meant was not clearly delineated within the document.

The first strand in this framework is conceptual understanding. Conceptual understanding requires students to understand not only procedures, but also why the concept is important and when it is useful (NRC, 2001). This requires students to make more connections between concepts. One way students can show conceptual understanding is by "being able to represent mathematical situations in different ways and knowing how different representations can be useful for different purposes" (NRC, 2001, p. 119). For example, when solving multiplication problems, some students may choose to draw pictures, others may create story problems, while others may use their knowledge of place value to create their own procedures. Having a conceptual understanding helps students "avoid many critical errors in solving problems, particularly errors of magnitude" (NRC, 2001, p. 120). This is evident in simple computations, particularly with fractions and decimals. Another benefit of conceptual understanding is reducing the amount students must learn because they can make connections across topics (NRC, 2001). Using the commutative property when learning addition (i.e., $3+4=4+3$) and multiplication (i.e., $3\times4=4\times3$) are examples. Having this understanding reduces the amount of facts students have to learn.

Procedural fluency not only includes knowing how to complete procedures, but also emphasizes using procedures "flexibly, accurately, and efficiently" (NRC, 2001, p. 121). Performing procedures flexibly, accurately, and efficiently requires students to understand the connections between concepts. For example, using pencil and paper in every situation is not flexible or efficient. Instead, students should be able to use multiple mental strategies and have experience with a wide range of tools so that they can select the best tool in a specific context (NRC, 2001, p. 122).

Procedural fluency and conceptual understanding should not be viewed in opposition to each other. This mindset leads to what Skemp (2006) *terms instrumental understanding*, described as "rules without reasons" (p. 89). Instead, procedural fluency and conceptual understanding support one another. The Committee identified specific ways these two strands are related: without procedural fluency, students struggle to gain deeper understanding; without understanding the procedures they practice, students may be prone to practicing procedures incorrectly; without making connections between procedures, procedures become inflexible and inapplicable; and without understanding procedures, students struggle to connect their informal knowledge and experience with mathematics to school mathematics (NRC, 2001).

Gray and Tall (1994) make a similar case of the interdependence of procedural fluency and conceptual understanding. They argue that those who are successful in mathematics use procepts, described as an "amalgam of concept and process represented by the same symbol" (Gray & Tall, 1994, p. 121). At the core of this notion is the idea that symbols are used flexibly so they can represent processes or concepts. For example, Gray and Tall (1994) discuss the procept 6, which "includes the process of counting 6, and a collection of other representations such as $3+3$, $4+2$, $2+4$, 2×3, $8-2$, and so on" (p. 121). The process and representations here all are ways to represent six, both through procedure and concept. The primary argument is more advanced students use their knowledge of procepts and proceptual methods flexibly while the less advanced students rely on procedures, often based on counting (Gray & Tall, 1994). This is similar to what the NRC (2004) explains as the primary difference between novices and experts. Novices see separate ideas. Experts not only know more, but they organize their knowledge based on relationships so they can use it flexibly. Flexibility is also important in the next strand of mathematical proficiency, strategic competence.

Strategic competence focuses on problem solving in that it refers to students' abilities to "formulate mathematical problems, represent them, and solve them" (NRC, 2001, p. 124). Students encounter problems that require strategic competence both in school and out of school. Flexibility is a key characteristic and develops by solving a variety of problems in a variety of contexts (NRC, 2001). The Committee describes these “nonroutine problems” as unique problems in which the student does not automatically know what method is best for solving the problem. Instead of going through rote procedures, students must apply their previous knowledge to create a way to conceptualize and solve the problem. By solving nonroutine problems, students increase their procedural fluency by deciding what strategies are most effective for solving the problems (NRC, 2001).

To develop the previous three strands of mathematical proficiency well, students need to develop the fourth strand, adaptive reasoning. The Committee defines adaptive reasoning as “the capacity to think logically about the relationships among concepts and situations” (NRC, 2001, p. 129). In short, adaptive reasoning allows students to see how procedures, concepts, and problem solving strategies relate to one another. Justifying their work is a key characteristic of this strand. In formal mathematics, justification often takes the form of proof. Formal proof is not how children begin their experiences with mathematics (Tall, et al., 2012). Instead, Tall et al., (2012) suggest proof develops as the following set of stages: perceptual recognition, verbal description, pictorial or symbolic representation, definition and deduction, equivalence, crystalline concepts, and deductive knowledge structures. As they note, however, “the general population builds mainly on the physical, spatial and symbolic aspects of mathematics” (Tall et al., 2012, p. 33). Most students do not get to formal axiomatic proofs unless they pursue advanced mathematics in college.

The final strand of mathematical proficiency is productive disposition, which covers a wide array of characteristics including: seeing the usefulness of mathematics, believing in the ability to do mathematics, and believing in the value of perseverance to learn mathematics (NRC, 2001). To develop the other four strands, students must see positive progress in their learning of mathematics and see the benefits of mathematics. At the same time, seeing their progress in learning requires practice with the mathematics. Thus, not only is productive disposition important for the development of the other four strands, it develops alongside these strands (NRC, 2001). While this strand supports the others and develops as they do, it is also impacted by students' experiences with mathematics, both out of school and in school (Boaler, 2015).

There are multiple levels of proficiency with these five, interwoven strands. It is also important to remember that proficiency and students' learning of mathematics develop over time and through multiple experiences (NRC, 2001). With these strands as a foundation, NCTM (2014) argues learning mathematics should be an "active process, in which each students builds his or her own mathematical knowledge from personal experiences, coupled with feedback from peers, teachers and other adults, and themselves" (p. 9). This requires a variety of experiences, including working on engaging, rigorous tasks, making connections, discussing mathematics and reasoning, getting and using feedback, and developing metacognitive skills (NCTM, 2014).

African Americans in the Mathematics Classroom

African Americans have valued education as a way of improving their condition since arriving in the Americas (Aldridge, 2009). However, there was a wide variation in educational opportunities for African Americans before 1900. For instance, Benjamin Banneker's education, while primarily received through home schooling in the 1700s, included time spent in a country school that taught both African American and white students in the winters (Leonard & Beverly, 2013). Throughout his life, Banneker created a working wooden clock, mathematics puzzles, surveyed Washington, D.C., and published almanacs. Nonetheless, his accomplishments in these areas, all of which required mathematics, were viewed as an exception to, rather than characteristic of, African Americans' capabilities in mathematics (Leonard & Beverly, 2013). His experience of learning through home schooling and through teaching himself was not uncommon though. In other instances churches provided education for African Americans (Franklin, 2009). From the first Black Episcopal church in Philadelphia in 1794 to the Methodists in Baltimore, churches and ministers often provided schooling opportunities for African Americans (Franklin, 2009). Many times, however, the education of African Americans was not considered. For instance, segregated schools existed in New England. In Midwestern states African Americans were excluded from common schools (Randolph, 2009). Thomas Jefferson proposed three years of schooling for every white child in Virginia in 1787, but made no such proposal for African American children because the economy depended upon their forced labor (Anderson, 1988).

In the early 1800s, this tension between educational opportunities and the importance of slave labor continued. While most southern states outlawed educating slaves, there was a major push to create educational opportunities for free African Americans (Anderson, 1988). This issue campaign created systems of schooling throughout the United States. By the mid -1800s, systems were providing formal education for free children (Anderson, 1988). After President Lincoln signed the Emancipation Proclamation, African Americans in the south began actively searching for formal educational opportunities through help from politicians, the Freedmen's Bureau, and northern organizations. African Americans worked to create and maintain their own schools; however, as African Americans began pursuing education, the power structure in the south was challenged (Anderson, 1988). To maintain their power, white people in the south helped to develop specific curricula that emphasized industrial education for African Americans and focused on farm labor, cooking, and construction. In other words, they made slave-like duties the curricula for African Americans in school (Anderson, 1988). Less than 4 years after Lincoln issued the Emancipation Proclamation, the Reconstruction Act of 1867 was passed. This act significantly reduced the impact of the Freedmen's Bureau, the organization which provided support for African American to attend schools.

Accordingly, this also marks the beginning of the nadir, a period from the end of Reconstruction through the early twentieth century (Berry et al., 2013). During this time, African Americans attempted to gain access to more education. However, most African American children were either denied access to education or were educated in segregated schools. Segregation was further codified when a majority of United States Supreme Court Justices validated the "separate but equal" policies of segregation in the 1896 *Plessy v. Ferguson* decision (*Plessy v. Ferguson*, 1896). Throughout this time period, African Americans rallied around the segregated schools to provide the best education possible given the legally segregated education environment (Anderson, 1988). Not only did African Americans have pride in their schools, many had strong academic reputations due to many factors, not the least of which were strong community support and highly qualified teachers (Morris, 2002). Walker (2000) identified excellent teachers, a strong curriculum and extracurricular activities, parent involvement, and a strong school principal as the four most valued aspects of the African American schools. Over a century later, these same four factors are consistently highlighted as most important to school success. Throughout these areas is a focus on relationships between individuals to support students socially and academically (Berry et al., 2013).

It is important to note that this situation was nowhere near ideal. Facilities were less than adequate. Resources were less than adequate. The African American community often times paid additional taxes to support their own education system (Anderson, 1988). However, the strong community support and influence along with a commitment to quality instruction by strong teachers was an attempt to make the best of a legally codified discriminatory situation. Much of the success the African American community was able to achieve changed after the *Brown v. Board of Education of Topeka* United States Supreme Court case.

In the 1954 *Brown v. Board of Education of Topeka* case, the United States Supreme court ruled segregated education to be unconstitutional, thus ending the codification of “separate but equal” schooling. While many African American parents sought desegregation as a way to gain more educational resources, the implementation of desegregation was slow. In 1955, the justices ruled in *Griffin v. County School Board of Prince Edward County* (also known as *Brown II*) for desegregation to occur with “all deliberate speed” (Berry et al., 2013, p. 29). Even still, without giving a specific timetable for desegregation, segregationists delayed implementing the court orders (Mayo, 2007). As desegregation began, the experiences of African American children also changed as they shifted from under resourced schools with more supportive personnel to the segregated schools with more resources but often with teachers possessing lower expectations. Snipes and Waters (2005) reported how one teacher noticed the differential treatment African American students faced from white teachers:

> I found that in most black schools Algebra I was required... [White teachers had] low expectations... We didn't do as good a job of recruiting black kids into academics as we did in sports... We are disinviting in math... Rather than saying we're going to deal with you differently, we will just put you in an easier class. What message do I send you if I just take you out of Algebra I and place you in General Math? The message is that I don't expect much out of you, even if I take you out of Algebra I and put you in two-year Algebra I. (p. 117)

Thus, very early in public school desegregation, African Americans were met with lowered expectations and situated as incapable of performing more advanced mathematics (Berry et al., 2013).

During this same time, the new math era was occurring. Brought on due to fears of inadequacy with the launch of *Sputnik*, the National Science Foundation was created and funded curriculum development for new math. Tate (2000) argued the emphasis on identifying talented mathematics students in the name of national security led to African American children and their mathematics experiences being ignored. Furthermore, African American children did not have access to many of the changes in curricula and pedagogy that came with new math (Berry et al., 2013). This is not an isolated experience for African Americans; instead, it typifies their experiences with each trend.

President Johnson began his Great Society initiatives in the mid 1960s. Many of these reforms were passed into law, including the Elementary and Secondary Education Act of 1965, which created the Title I program. The Civil Rights Act of 1968 and the

Voting Rights Act of 1965 also were passed and signed into law. Within this context of advancing civil rights, desegregation also began to occur in earnest. Coleman et al. (1966) released their *Equality of Educational Opportunity* report (also called the *Coleman Report*). The authors argued students' backgrounds and socioeconomic factors were more important in outcomes than school resources. Policymakers used this report to focus on peer effects (Berry et al., 2013). The peer effects policy held a deficient view of African Americans as the enactment of the policy led to the belief that African Americans would score higher on tests if they learned with White students.

To help create these desegregated classrooms, busing was commonly used. However, busing was not used equally. Usually, African American students were bused from their home school to another school in an attempt to achieve more diverse student populations (Berry et al., 2013). While the peer effect was often cited as a rationale for busing, African American students were usually resegregated in their mathematics classes, as they were tracked into lower level, basic math courses. Doughty (1978) argued nearly 75% of school districts resegregated students due to ability grouping; furthermore, many African American students were relegated to special education programs, with estimates as high as over 90% being misclassified. This resegregation and relegation to special education programs marks the beginning of tracking, which lead to diminished expectations and opportunities for African American students (Oakes, 1990).

Another important result of desegregation occurred in terms of who taught African American students. Before the *Brown* decision, African American teachers and principals were trained as well as possible and held in high regard (Walker, 2000; Tillman, 2004). Ladson-Billings (2004) argued many of these professionals received better training than their White counterparts; however, with desegregation, the vast majority of the African American teachers were removed from their positions (Ladson-Billings, 2004; Tillman, 2004). These losses not only had severe economic repercussions for the former teachers, but also threatened the socioemotional and academic success of African American students (Tillman, 2004), as they went from a more supportive, communal environment to the often hostile environments of desegregated schools.

Instructionally, these changes happened during the "back to the basics" movement in mathematics education. Even though the back to basics movement resulted in somewhat higher test scores for African American students, it did not adequately prepare them for higher-level mathematics courses (Tate, 2000). Many African American students did not ever experience this shift in instruction as their teachers had consistently focused on procedures, drill, and memorization. If anything, the increase in testing allowed educational institutions to normalize the viewpoint of African Americans as incapable of doing and participating in more advanced mathematics (Berry et al., 2013).

A Nation at Risk reignited public fears about inadequate education in the early 1980s. In response, many states included Algebra I as a graduation requirement. Although many of the African American schools before desegregation offered Algebra I and even more advanced courses, many African American students did not move past Algebra I (Berry et al., 2013). Robert Moses, seeing the lack of African Americans in more advanced mathematics courses, founded the Algebra Project, a curriculum designed for African American students to learn algebra so they could take more advanced mathematics courses. The curriculum was an important step, especially when instruction for African American students continued to focus on basic skills (Berry et al., 2013).

To help meet the lofty goals set by policymakers in response to *A Nation at Risk*, NCTM began a path toward curriculum standards. NCTM published the *Agenda for Action* in 1980, calling for more problem solving, diverse assessments, and support to help all diverse students achieve in mathematics (NCTM, 1980). Lambdin and Walcott (2007) argued the standards and accountability phase began with the NCTM's publication of *Curriculum and Evaluation Standards for School Mathematics* in 1989. This document had content standards and process standards for students in Kindergarten through high school. However, it also sparked a heated debate which led to the "math wars," discussed previously. While the debate over pedagogy raged, issues relevant to African American students were largely ignored. Berry et al. (2013) explained, "For Black children, issues of race, racism, identity, and conditions are not under consideration in the 'Math Wars'" (p. 41). Just as in previous reforms, the needs of African American learners were not considered.

In 2000, NCTM published *Principles and Standards for School Mathematics* as an update to the *Curriculum and Evaluation Standards for School Mathematics*. This update was more specific in terms of content at specific levels, but went a step further with its six principles for school mathematics: equity, curriculum, teaching, learning, assessment, and technology (NCTM, 2000). The equity principle is listed first and encouraged schools to possess high expectations for all students, to provide any needed supports for students to achieve success, and to accommodate the diverse learners of mathematics (NCTM, 2000). The equity principle received criticism, though. Martin (2003) criticized the principle for being too broad and for ignoring the complexities of equity issues.

> The Equity Principle...contains no explicit or particular references to African American, Latino, Native American, and poor students or the conditions they face in their lives outside of school... I would argue that blanket statements about *all* students signals an uneasiness or unwillingness to grapple with the complexities and particularities of race, minority/marginalized status, differential treatment, underachievement in deference to the assumption that teaching, curriculum, learning, and assessment are all that matter. (p. 10)

Berry et al. (2013) argued that not only does the NCTM document favor a focus on teaching, curriculum, learning, and assessment, but many researchers in mathematics education and policymakers do, too. The *No Child Left Behind Act* is one such example, as it focused on teaching, curriculum, and assessment as the primary drivers to increasing student achievement. What seems to be a common theme with reform efforts happens once again—instruction for African American students focuses on basic skills, that will this time be measured by the mandated assessments (Berry et al., 2013).

Based on these sociohistorical experiences, African Americans remain underrepresented in advanced math classes. Martin (2000) describes the underrepresentation as part of "the legacies of mathematical experiences characterized by differential treatment and denied opportunity in socioeconomic and educational contexts" (p. 8). This ongoing legacy of denied access has had negative impacts for generations of African American students (Berry et al., 2013). Negative perceptions of African Americans in mathematics remain today, with successful African Americans viewed as atypical (Leonard & Beverly, 2013).

Teaching Styles and Learning Preferences

The previous section discussed more societal trends that positioned African Americans as a “less knowledgeable other” in mathematics. Many African American students experience mathematics as a gatekeeper rather than a gateway subject (Martin, Gholson, & Leonard, 2013). Some argue students’ mathematics achievement is more directly related to school factors rather than home factors (e.g., Waddell, 2010). Thus, the following is a review of the relationship between African American students’ learning preferences and the instruction they receive.

Willis (1989) conducted a review of the literature on the learning styles of African American children. While the existence of learning style is highly debated and I focus on learning preferences, this is the language used by Willis (1989) that later work on learning preferences builds upon. Learning style is defined by Willis (1989) as “a way of perceiving, conceptualizing, and problem-solving... [and] a preference for the way of interacting with and responding to the environment” (p. 48). In the review, Willis (1989) argues that African American children have a different learning style than the dominant style. Before presenting the review, Willis articulates four assumptions. First, learning style impacts school experiences for all learners. Relatedly, students’ culture affects their learning style. Third, African culture influences African Americans. Finally, and perhaps most importantly, differences in learning style are simply differences, not right or wrong. Based on the review of the literature, Willis (1989) classified African American learning styles into four categories:

1. *Social/affective*: people-oriented, emphasis on affective domain, social interaction is crucial, social learning is common.

2. *Harmonious*: interdependence and harmonic/communal aspects of people and environment are respected and encouraged, knowledge is sought for practical, utilitarian, and relevant purposes, holistic approaches to experiences, synthesis is sought.
3. *Expressive creativity*: creative, adaptive, variable, novel, stylistic, intuitive, simultaneous stimulation is preferred, verve, oral expression.
4. *Nonverbal*: nonverbal communication is important (intonation, body language, etc.), movement and rhythm components are vital. (p. 54).

Shade (1997) used a similar approach, characterizing the learning preference of African Americans as focusing on holistic, relational, and field-dependent learning. Berry (2003) describes relational learning as "freedom of movement, variation, creativity, divergent thinking, inductive reasoning, and focus on people" (p. 246). Relational learning contrasts with analytical learning, which is privileged in schools (Shade, 1997). Similarly, Malloy and Malloy (1998) characterize the learning preference of African American students as holistic, field-dependent, and interdependent. In a related study, Howard (2001) studied how African American elementary students interpreted culturally relevant teaching. The student responses align with Willis' (1989) review of learning preferences, specifically in the emphasis on caring (social/affective and harmonious), establishing community (social/affective and harmonious), and engaging classroom environments (expressive creativity and nonverbal) (Howard, 2001).

Malloy and Jones (2002) investigated African American students' problem solving strategies in a group of precollege eighth grade students. They found two characteristics of the students' problem solving to be unique: holistic reasoning and confidence in their abilities (Malloy & Jones, 2002). The use of holistic reasoning supports Shade's (1997) characterization of African American learning practices. The confidence in their abilities may be more related to their precollege program.

Berry (2003) suggested students' learning potential is maximized when learning preferences and school culture are closely aligned. However, African American students not only receive traditional mathematics instruction, but this instruction is often opposed to their learning preferences. As Tate (1995) explains, "typical mathematics pedagogy emphasizes whole-class instruction," (pp. 166-167) where students listen to teachers describe one way to solve a math problem before working individually on a set of problems to practice the newly learned skill. Malloy and Malloy (1998) suggest schools assume students will adapt to the culture the school and teachers create. When students fail to adapt, they are tracked into lower level mathematics courses where conceptual understandings are replaced with algorithms and procedures, which in turn affects "students' perceptions of themselves as members of the mathematics community" (Malloy & Malloy, 1998, p. 248). As previously explained, this practice usually situates African Americans in lower tracked courses and, consequently, as outsiders to the mathematics community.

This is not to say African American students never experience good teaching that aligns to their learning preferences. African American parents and students expressed specific strategies they believe represent excellent teaching. According to Thompson (2004), the most common characteristics African American parents and students want were:

- teachers to make the curriculum comprehensible.

- teachers to make the curriculum interesting.
- teachers to give extra help during class, instead of telling struggling students to come before school, after school, or during lunch for help.
- teachers to be patient in explaining subject matter.
- a challenging curriculum.
- beneficial homework that is collected, graded, and related to class work and tests.
- teachers to encourage students to ask questions, instead of penalizing them for doing so (p. 42).

Many of these characteristics are reflected in Ladson-Billings' (1995) conception of culturally relevant teaching. Ladson-Billings (2009) identified five important lessons regarding implementing culturally relevant teaching: students who are treated as competent individuals are likely to act as such; scaffolding helps students build on prior knowledge to learn new things; instruction should be the primary focus of the classroom; use what children know to extend their thinking and abilities; and, being an effective teacher requires not only knowing pedagogy, but also your students. Culturally relevant teaching is just good teaching (Ladson-Billings, 19955). The problem, then, is why so little good teaching happens in classrooms with a majority of African American students. Moreover, most of the practices identified are not present in traditional mathematics classrooms.

Malloy (2009) examined orientations and practices of middle school teachers had toward African American students. Data consisted of classroom observations, teacher interviews, student surveys, and an assessment to measure student understanding. Of the 44 teachers studied, Malloy chose to examine the four teachers whose students showed the most growth on the assessments. Although their instructional practices varied, Malloy (2009) noted they shared three common areas of practice: reflection on instruction, building communities of learners, and giving their students voice. Moreover, these successful teachers interwove memorization, procedural, and conceptual tasks into lessons, emphasized mathematics discussions and student reasoning, and promoted collaboration between students and teachers. In addition to these practices, Malloy (2009) described the teachers' orientations toward African American students. They shared a strong belief in their students' abilities to learn mathematics, addressed varied learning styles, valued students' previous knowledge, and created safe, caring environments. Many of these findings implement the strategies (i.e., productive disposition, high expectations for all students, differentiating instruction) suggested by NCTM (2014). These orientations and practices helped the teachers create successful learning environments for African American students.

Tate (1995) described how one middle school mathematics teacher implemented culturally relevant teaching. Based on observations of the teacher, Tate (1995) identified six strategies: communication, cooperative learning, inquiry throughout the learning process; critically questioning; open-ended problem solving connected to real life; and, social action. To teach the content, the teacher invited students to discuss problems in their communities. After identifying problems, students researched the causes of the problem and developed strategies to solve the problem. The focus shifted from the content to the real world. This open-ended problem solving required students to "think about mathematics as a way to model their reality" (Tate, 1995, p. 170). In the words of the SMPs, they modeled with mathematics. As students worked to solve the problems they identified, they worked cooperatively with each other, with the teacher, and with their community. Doing so allowed them to question the institutional structures that created the problem, thus developing a critical consciousness. Once they settled on a course to solve the problem, the students communicated their ideas to the community. While vastly different than the typical mathematics classroom, this approach aligns well with Willis' (1989) categories by developing practical knowledge that focuses on real problems and creative solutions to those problems. The mathematics concepts become more meaningful when they are situated within the real-world problems their communities face (Tate, 1995).

Malloy (2009) and Tate (1995) offer some insight into what works for African American students in terms of teaching and learning. There are other studies, though, that give insight into ineffective practices. For example, Lattimore (2005) explored African American students' perceptions on their preparation for high stakes mathematics tests. Students reported large amounts of lecture, repeated drill, and a lack of engagement with the content. In terms of how these practices prepared the students for the tests, students felt "inadequate at best" (Lattimore, 2004, p. 143). Murrell (1994) also examined practices of math talk in the classroom. Teachers often viewed math talk as a way for students to develop meaning. However, students did not share this understanding. They viewed math talk as just another skill "to be mastered and exhibited in the same way they exhibit other aspects of school performance such as doing one's work, turning in homework, and listening to the teachers" (Murrell, 1994, p. 564). Instead of building the understanding of math talk as a way to express their reasoning and strategies, the African

American male middle school students Murrell focused on just viewed it as another expectation with which they were expected to conform.

While these studies provide some insight into the relationship between mathematics teaching and learning for African American students, there are not many that provide more detail (Jackson & Wilson, 2012). Much of what does exist describe the culture clashes Malloy and Malloy (1998) described. For example, Stiff and Harvey (1988) argued African American students who tried to make mathematics content relevant to their lives were often chastised for focusing on irrelevant topics. Glaser and Silver (1994) found similar experiences when African American middle school students used their lived experiences to solve problems. If learning is maximized when instruction is tied to learning preferences (Berry, 2003), but the learning preferences of African Americans are often marginalized or ignored (Stiff & Harvey, 1988; Malloy & Malloy, 1998; Berry et al., 2013), what learning outcomes can logically be expected?

Mathematics Identities

Identity is a term that has varied definitions due to its theoretical conceptions across many disciplines (Holland et al,. 1998). In the education literature, identity has often been treated as a term that needs limited explanation. For example, Wenger (1998) describes "identity in practice" as "a way of being in the world" (p. 151). While this provides a brief description, it offers little insight into the components that influence the creation of identity, let alone any suggestion that a person can have multiple identities. Instead, Wenger's explanation seems quite limiting in the lack of further clarification—such as what constitutes the world—and in the singularity implied in "a way." In short, the concept of identity has not been fully operationalized.

Around the same time, Holland et al (1998) suggested another view of identity as "self-understandings, especially those with strong emotional resonance for the teller [of the self-understandings]" (p. 3). In this view, a person's own conception of who they are informs not only how they want others to perceive them, but also how they should act to achieve or maintain their own conception of their identity. While this approach provides more explicit individual agency than Wenger's view, it still lacks any reference to components that create these self-understandings.

Gee (2000) recognized this limitation as he advanced his framework for identity, focusing on "the 'kind of person' one is recognized as 'being,' at a given time and place, can change from moment to moment in the interaction, ... from context to context, and, of course, can be ambiguous or unstable" (p. 99). This view directly contradicts the implied singular nature of identity in the other initial definitions by recognizing the multiplicity innate in a person's identity. Additionally, Gee's explanation recognizes the importance of context, or "time and place" in the creation of identity. Thus, Gee's view of identity expands the previous definitions by providing for the multiplicity of one's identities and of the importance of context.

Gee (2000) furthers his definition by offering four different ways identity can be viewed: nature, institution, discourse, and affinity. Nature identities can be thought of as identities created by processes through which an individual and society has no control. For example, a person born with Down's Syndrome will have that identity due to natural processes which neither the person nor society could control. Although these identities are imposed on individuals, Gee (2000) argues the only way these identities gain traction is “because they are *recognized*... through the work of institutions, discourse and dialogue, or affinity groups” (p. 102).

Institution identities come from authorities in institutions. For example, when I taught fourth grade, my position stemmed from the authorities given to me by the principal and local school board. I was not a fourth grade teacher because I said so or because of what nature made me or because of the social circle I maintained. It stemmed from a position in an institution overseen by some authorities. Important in this view of identity is the continuum on which it lies, varying from a calling to an imposition. Institutional identities that are chosen, such as mine as a fourth grade teacher, are closer to the calling end. Those that are imposed, such as the identity of prisoner, lie at the other end.

Gee’s third identity is a discourse identity. Gee (2000) describes these identities as “an individual trait” determined by “the discourse or dialogue of other people. It is only because other people treat, talk about, and interact with” other people with certain traits that those traits come to define the person (p. 103). Much like institutional identities can be a calling or an imposition, discourse identities can either be seen as an ascription or an achievement. One reasonable interpretation of this type of identity is to use it to determine who is unsuccessful (ascription) or successful (achievement) based on the discourse of those around them in a particular setting.

The fourth identity Gee describes is the affinity identity. In this view, members of affinity groups gain an identity related to that group. For example, fans of a sports team belong to a specific affinity group by their participation in cheering for their team. As Gee (2000) explains, “their allegiance is primarily a set of common endeavors or practices and secondarily to other people in terms of shared culture or traits” (p. 105). Thus, the groups with which we associate and which we participate in can form one identity in this view.

The lack of agreement in defining identity can be problematic when using identity as a concept in research. For the purposes of this study, I conceptualize identity as the way a person and other people view that person in a given context. Thus, an individual’s identity can change based on context and on the people around an individual. In addition to creating a clear and operational definition as Sfard and Prusak (2005) suggested, it is also helpful to narrow the concept to a specific field. In this case, an academic identity is important, specifically mathematics identity. According to Murrell (2008), “an academic identity is a form of social identity in which the learner projects, maintains, and improvises an image of self as a learner... Academic identities are socially situated and are mediated by what happens in the social practices of schooling” (p. 97). Murrell’s definition complements the definition of identity presented above as it addresses the individual’s role in shaping his or her own identity, while also allowing for the influence of the discourses within social practices. While this narrows the focus of identity to the realm of academics, this is still too broad for the study of African American elementary students’ mathematics identity.

In his book, *Success and Failure Among African-American Youth: The Roles of Sociohistorical Context, Community Forces, School Influence, and Individual Agency*, Martin (2000) defines mathematics identity as “the participants’ beliefs about (a) their ability to perform in mathematical contexts, (b) the instrumental importance of mathematical knowledge, (c) constraints and opportunities in mathematical contexts, and

(d) the resulting motivations and strategies used to obtain mathematics knowledge" (p.19). Martin used this definition to explore the intersection of race and learning mathematics in middle school boys. Martin's study resulted in a four-level framework—sociohistorical, community, school, and individual—which he considers relevant to African American identity generation and regeneration.

At the sociohistorical level, Martin (2000) emphasizes the historically discriminatory practices and procedures that disallowed African Americans from becoming full participants in many areas of society, including in mathematics. This sociohistorical level impacts the community level. As Martin (2000) explains, parents and other community members "send implicit and explicit messages—positive and negative—about the importance of mathematics learning and knowledge to their children" (p. 38). The children internalize the messages they receive which influences the way the (re)create their mathematics identities in the mathematics classroom.

The mathematics classroom is located in the school level of the framework. At this level, Martin focuses on the norms of the school and classroom, the teacher's beliefs and instructional practices, and the curriculum. His study provides a particularly insightful case, as it not only touches on how teachers' experiences affect their interactions with students, but also shows how creating new norms, in this case by using The Algebra Project curriculum, led to resistance from students used to a more traditional experience in the mathematics classroom. Thus, the various activities that happen in school and in the mathematics classroom not only builds on the identities the students bring with them, but may require them to negotiate and renegotiate these identities when faced with interactions with teachers and curricula.

Martin (2000) presents data that paint several students as unwilling to accept the new norm in the classrooms using The Algebra Project; however, there were also students who became successful. Martin (2000) attributes their success to their individual agency, the fourth level of his framework. In this level, Martin focuses on students' perceptions of knowing and doing mathematics. Specifically, he identifies students' abilities to focus on the big picture of mathematics learning in terms of their goals and the agency they need to reach their goals as key factors of success (Martin, 2000).

Martin's (2000) work is important for several reasons. First, as Jackson and Wilson (2012) claim, Martin's publication marked the beginning of a research focus on the experiences of African American students learning mathematics. According to Jackson and Wilson's (2012) review, "13 studies... inquired into the experiences of successful African American learners in mathematics" after Martin's (2000) work. Thus, one contribution is the methodological shift to value the voice of students as they describe their experiences.

Second, Martin's (2000) framework provided a theoretical basis on which others have drawn. For example, Cobb and Hodge (2002) discuss three different concepts of identity, normative, core, and personal that are important in the mathematics classroom. For them, normative identity is "the obligations that the teacher and students interactively constitute and continually regenerate" in the classroom (p. 188). Methodologically, Cobb and Hodge (2002) suggest classroom observations that are preferably videotaped when examining normative identities. Core identity is more associated with the students' sense of self and their goals. To examine core identities, Cobb and Hodge (2002) suggest exploring students' long term goals, their desire to succeed in school and in mathematics, and how they perceive other students' desire to succeed in school and mathematics. Finally, "personal identity is concerned with who students are becoming in particular mathematics classrooms" (Cobb and Hodge, 2002, p. 190). Using interviews to understand what students think of their obligations in the mathematics classroom as well as how they value these obligations is suggested.

A few years later, Cobb, Gresalfi and Hodge (2009) propose an updated "interpretative scheme" that, in their words, "makes contact with [the school level] of Martin's framework by focusing on the microcultures established in particular classrooms" (p. 42). In their scheme, Cobb et al (2009) use the constructs of normative identity and personal identities. For Cobb et al (2009) normative identities are "jointly constituted norms" by teachers and students, not just norms set by the teacher (p. 57). Personal identities were more complex, with four categories being explained. However, at the root, Cobb et al (2009) argue that personal identities focus less on actual activities happening in the classroom and more on their perspective and assessment "of how the classroom 'works'" (p. 64). This approach accounts for what is successful in each classroom by examining the normative identities, while also accounting for individual student perspectives as they assess the workings of the classroom to develop personal identities. Although not as comprehensive as Martin's (2000) framework, they argue it is yet another tool to add to our overall understanding of identity development in the mathematics classroom (Cobb et al, 2009).

Other studies have used Martin's framework both directly and indirectly when examining mathematics identities. For example, Boaler and Greeno (2000) studied forty-eight high school students in an Advanced Placement calculus course. The racial constitution of their sample was not reported. In their study, they interviewed eight students from six different schools. Therefore, while never explicitly mentioning Martin's (2000) framework, it is associated with his school level (Hodge, 2008). Moreover, because all of the schools were in an affluent area, it is not unreasonable to infer that, at a minimum, the community factors could be considered much different than those in Martin's (2000) work, but potentially the sociohistorical level, as their work focused on different populations in terms of socioeconomic status.

In their findings, Boaler and Greeno (2000) describe a connection between pedagogical style of the teacher and students' development of mathematics identities. Specifically, students in traditional classrooms "experienced an important conflict between the practices in which they engaged, and their developing identities as people" (Boaler, 2002, p. 44). When this conflict existed, students were more likely to not pursue mathematics further. In classrooms that focused more on discussion and participation, students "described their participation in active terms that were not inconsistent with the identities they were developing in the rest of their lives" (Boaler, 20002, p. 45). Thus, Boaler and Greeno (2000) established a link between teachers' pedagogical choices and the development of students' mathematics identities. What is not explored is what constitutes success in terms of learning. Instead, Boaler and Greeno (2000) simply note, "as the students were taken from AP calculus classes, they may all be regarded as successful students of mathematics, having all chosen to take mathematics into a fourth year, at an advanced level" (p. 175). What exactly success is, other than taking an advanced mathematics course, and how success relates to students' mathematics identities are not clearly explained.

Hodge (2008) conducted a similar study by examining students' roles in different elementary classrooms. Again, with the classroom level of analysis, she associates with Martin's (2000) school level. In her study, she followed eight students, seven White and one African American, in an affluent school over the course of their first and second grade years. By examining the classroom actions she not only looked at the normative identities jointly constructed (Cobb et al, 2009), but she also attempted to delve more deeply into the students' personal identities. However, she found it difficult to determine if the students were developing positive mathematics identities or merely complying with the teachers' expectations. Using students' narratives to explore their identities, Hodge (2008) argues, allows for the exploration of students' "place in, and understanding of, learning mathematics" in the classroom (p. 49). Thus, the link to learning mathematics is established. Like the Boaler and Greeno (2000) study, what it means to be successful in learning mathematics is not clearly defined.

Zavala's (2014) work also builds on Martin's (2000) idea of mathematics identity. However, she takes a critical race theory approach and a Latino Critical Theory approach "to examine Latina/o students' narratives of learning mathematics in a multi-lingual urban high school" (Zavala, 2014, p. 55). To conduct her study, Zavala used qualitative methods, namely interviews, stimulated recall, and focus groups to create case studies based on the students' narratives. She found race and language to be important factors in the development of the students' mathematics identities; moreover, Zavala (2014) argues that teachers should "learn how aspects of identity... specifically those related to race and language, may be important in the lives of their own students" so that they can make more strategic pedagogical decisions to positively influence student success (p. 80).

Zavala's (2014) study is important in the way it differs from the previous studies presented here. First, she values the students' voice through the use of testimonio, which "privileges the experiences of people marginalized by institutions such as schooling within a U.S. context, and highlights the way they show agency as they navigate these settings" (p. 62). While the other pieces used interviews with students as a way to collect data, Zavala's (2014) use of testimonio gives more privilege to the student voice in constructing a narrative or counternarrative to the dominant discourse.

Whereas Boaler and Greeno (2000) and Hodge (2008) focus on more affluent students in majority White school settings, Zavala (2014) focuses specifically on a subset of students of color often associated with the deficit views, Latina/o students in an urban high school. Not only does this provide a boost to the literature, it allows her to focus on how racial identities impact the development of mathematics identities. This continues Martin's (2007) description of the multiplicity of identities. Specifically, Martin (2007) explains:

> Because mathematics is only one aspect of a person's life, mathematics identities do not develop in isolation from the other identities that people construct (e.g., racial, cultural, ethnic, gender, occupational, academic). For some individuals, these multiple identities may unfold in ways that make them incongruous... For others, there may be explicit attempts to merge these identities so that they exist in unison. Any challenge or affront to one is then interpreted as a challenge to others (p. 151).

One of the areas not explored in the Boaler and Greeno (2000) and Hodge (2008) pieces are direct connections between mathematics identity, racial identity, and mathematics learning. Much of this can probably be credited to a majority of White participants. Zavala's (2014) examination of the interplay between these three concepts—mathematics identity, racial identity, and mathematics learning—is a step in the right direction. This is especially true taken in light of Martin's (2007) assertion that challenging one identity challenges all of them. Therefore, in an effort to better understand the literature on racial identities and mathematics identities as they relate to learning, it is also necessary to review studies that specifically link identity and learning.

The relationship between the learning and identities of students of color is not a new research fad (Nasir, 2002). As Stinson (2006) argues, it has long taken a deficit perspective with discourses of deficiency and discourses of rejection. For example, Nasir (2002) highlights the influential Clark and Clark study of 1950 in which the authors had African American children choose between white dolls and black dolls. When most of the children chose white dolls, Clark and Clark argued segregated schools had damaged the African American students' identities (Nasir, 2002). Other avenues explored have been in terms of teaching practice and in learning.

Berry, Thunder, and McClain (2011) examined the relationship between identity and learning by studying 32 successful African American males in middle school. In the phenomenological study, Berry et al (2011) were concerned with how the participants constructed their mathematical identities, how they construct their racial identities in learning mathematics, and how these two identities are related. In terms of their mathematical identities, the researchers identified four positive factors in the participants' responses: gaining computational fluency early, extrinsic recognition (e.g., grades and test scores), strong relationships between school and home, and meeting the perceived difficult challenge of being successful in mathematics (Berry et al, 2011). These four factors provide limited guidance in how identity and learning are connected, other than the role of positive reinforcement and not falling behind early.

In terms of racial identities, Berry et al (2011) and Zavala (2014) have similar findings. Specifically, race plays a role in how they perceive others. Zavala (2014) described students who thought of their own experiences as color blind, while mentioning several racial stereotypes to explain their poor behavior or Asians' success. Berry et al (2011) describe African American students feeling isolated, as there are few other African Americans in their advanced mathematics classes. In short, both studies note how race impacts students' identity (re)creation. Berry et al (2011) describe this as a sense of "otherness," namely that they are unlike the others, both in their classes and in their perceptions of less successful African American males. What was consistent in all of the participants, though, was a sense of internal strength and characteristics that allowed them to achieve success in mathematics (Berry et al, 2011). This internal agency is an important area for further exploration, but is not clearly linked to learning mathematics.

Summary

This chapter started with a review of mathematics instructional trends in the United States and of how students learn mathematics. The variety of instructional trends and the constant tension between traditional mathematics and reformed mathematics provides an important insight into the variety of strategies seen in today's classrooms. Moreover, it provides a point of comparison for how students develop each of the five strands of proficiency on their journeys to mathematical proficiency. However, even with this information known, many of the trends have not impacted African American students

(Berry et al., 2013). Instead, this population, and others, has continued to be underserved with teachers who are not as experienced or as qualified and who do not always possess high expectations. Thus, the sociohistoric legacy of continued discrimination against African Americans in the mathematics classroom continues as the dominant discourses paint African Americans as either deficient or defiant in rejecting schooling (Stinson, 2006).

The learning preferences and teaching styles section reaffirms not only the disparity in traditional and reformed mathematics, but also in the educational experiences of African American students. Traditional mathematics instruction is at odds not only with the current literature of best practices, but also with African American students' learning preferences (Berry, 2003; Malloy & Malloy, 1998). Accordingly, this has an impact on students' mathematics identity development. While mathematics identity can be difficult to operationalize, it is also an important concept to understand how students relate to mathematics. Moreover, as Martin's (2000) study shows, exploring student identity provides one way to privilege student experiences, instead of focusing exclusively on teacher and curricular issues.

Chapter 3
Methodology

Qualitative methods were used to explore African American third grade students' classroom interactions with mathematics in order to better understand factors that promote positive mathematics identities. More specifically, I used a case study design to examine how three African American third grade learners experienced the mathematics classroom and how their experiences informed their mathematics identities. The research question for this study was:

- How do third grade African American students generate mathematics identities from their experiences in the figured world of the mathematics classroom?

In this chapter, I describe the case study method, the participants, the setting, the data collection procedures, and data analysis for this study.

Case Study Method

A wide range of methods are used to research identity, ranging from qualitative methods, including narrative identity and semi-structured interview techniques, to quantitative surveys and questionnaires (Watzlawik & Born, 2007). This is partly due to the range of disciplines that use identity as a concept of interest (Holland et al., 1998). As Kroger (2007) noted, quantitative studies have offered information about general patterns of identity development, while qualitative studies are more prone to explore identity construction through case studies. Deciding which approach to use depends on what the researcher wants to study. In her review of different approaches, Kroger (2007) suggested quantitative methods have been used when researchers are interested in how identity is stable or varies over time, in events that are related to changing identity statuses, and in one or two specific aspects of identity formation in a large group of individuals.

Qualitative studies often explore identity more holistically and from the participants' perspective, which is more difficult to do with pre-defined variables operationalized in a particular way. Ultimately, Kroger (2007) concluded there is not a single best way to explore the concept of identity; instead, the research question should drive the methodology. As my research question focuses on the participant's perspective, I used a case study method.

Yin (2014) explained case studies as appropriate when trying to understand a real-world phenomenon in which understanding the phenomenon requires relevant context around it. According to Yin (2014):

> A case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (p. 17)

To implement a case study, Yin (2014) identified 5 components of design: (1) the case study's question(s); (2) propositions; (3) unit(s) of analysis; (4) logic linking data to propositions; and, (5) criteria for interpreting findings. For this study, the research question serves as the case study's question. The extant literature and theoretical framework create three distinct propositions that focused analysis. Specifically, the idea that pedagogy is important to students' mathematics identities and the theoretical ideas of positionality and space of authoring were important topics to explore. The unit of analysis for this study is each student. Logic linking data to propositions, discussed more in the data analysis section, focused on using pattern matching and provisional codes developed from the previously identified propositions. Finally, Yin (2014) suggested criteria for interpreting findings usually refer to statistically significant data in quantitative studies. For qualitative studies such as this one, the highlighting rival explanations is important.

Each student was treated as a single case in this study. Thus, the study takes a multiple case study approach. When comparing cases, I used a case oriented replication strategy for cross case analysis. This technique is used to examine each case theoretically to determine how they match up to the theory. For this study, ideas of positionality and spaces of authoring as important ways in which identities are formed in figured worlds comprised the focus.

Setting

The site of the research was Wildcat Academy, a pseudonym. Wildcat Academy was chosen as the site for two reasons—population and access. The population of the school matched the desired population of the research question, namely African American students. Moreover, I was a teacher at the school. Thus, I had more access to participants and contextual information about the practices in the school. Wildcat Academy was a large urban school in the north central Midwest United States serving nearly 900 students in grades prekindergarten through eight. The school had persistently been labeled a failing school in terms of achievement performance by the state. Each grade level in kindergarten through sixth grade had three teachers, with four teachers per grade in seventh and eighth grades. Figure 3.1 displays the racial composition of the teachers and administrators at the time this study was conducted. Each classroom served 25 to 30 students, with the average being 28 students per classroom. In addition to the regular classroom, the school employed a cadre of resource teachers that ranged from music to physical education to creative writing. I served as a STEM resource teacher.

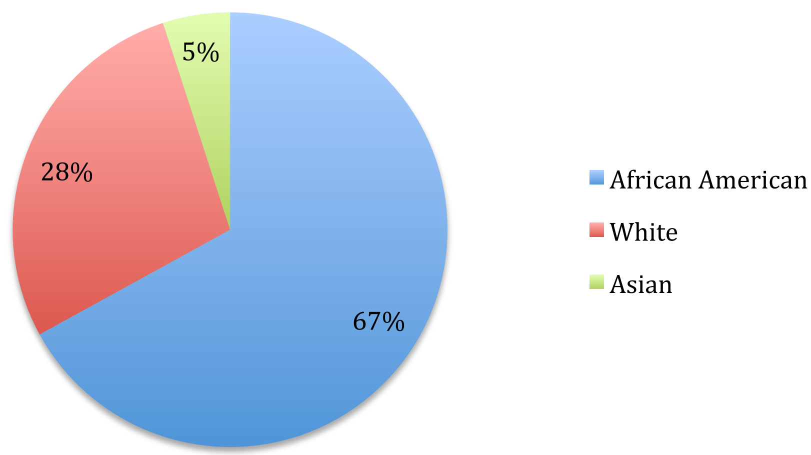


Figure 3.1. Racial composition of the teaching staff at Wildcat Academy.

The third grade teaching team consisted of three teachers. The administration organized the team to be departmentalized, a process in which each teacher specialized in one subject area. One teacher taught reading and writing. Another teacher taught science and social studies. The third team member, Ms. Madison, a pseudonym, taught mathematics. This study took place in Ms. Madison's classroom where she used the district-mandated curriculum, *Engage NY*. The *Engage NY* curriculum was very scripted and led to a very traditional mathematics classroom in which students were routinely positioned as receivers of knowledge. Students rarely participated in inquiry-based activities or in cooperative learning.

Based on my observations, a typical class could be segmented into four distinct segments: fluency, concept work, application, and assessment. The fluency segment lasted approximately fifteen minutes and consisted of a variety of practices for students to practice basic skills. Many days this focused on skip counting to reinforce relationships in multiplication and division. Ms. Madison used a variety of methods from student led skip counting to teacher led practice with skip counting. The concept work focused on the big ideas of the curriculum unit. For example, students partitioning a number line into fractional parts was part of a concept development around linear models of fractions. An application problem usually followed the concept development. This problem required students to use the concept just practiced or a closely related big idea. For example, in a geometry lesson on area, the application problem focused on composite shapes. Lessons usually ended with an assessment on a worksheet or exit ticket. Some days were different, such as during a unit test or during computer work days. On computer work days, students would log on to an adaptive learning system, ALEKS, and complete work on their level.

The students who attended Wildcat Academy were primarily neighborhood students. Only five buses served the school with many drops being within a three-mile radius. High levels of poverty and violent crime marked the neighborhood the school served. Accordingly, all students qualified for free and reduced lunch, a measure of poverty. Racially, the students were categorized[1] as predominantly African American with less than two percent of students being categorized as Asian, Hispanic, White, or other. Figure 3.2 displays the racial composition of the students attending Wildcat Academy at the time this study was conducted.

[1] I use the term "categorized" as I do not presume to know the race each student identified.

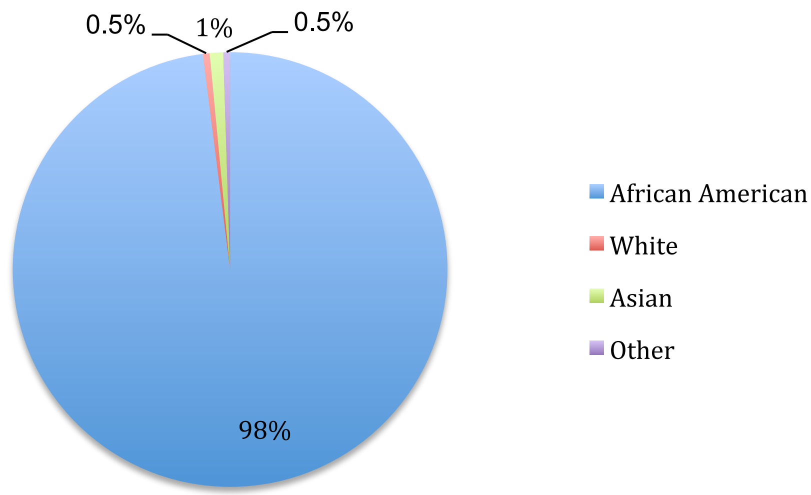


Figure 3.2. Racial composition of students at Wildcat Academy.

Participants

I began planning for this study before I started teaching at Wildcat Academy. I had very few criteria for participants. They clearly had to be African American third graders; however, I did not want any academic criteria. Instead, I wanted students with a variety of backgrounds and experiences who could articulate their ideas in a conversation. Thus, purposive homogenous sampling was initially used to identify participants who fit this case's unique contexts, specifically African American third graders. In this case, this eliminated very few participants as most of the third grade class was African American students. Thus, reputational case selection was used to identify four African American third grade students, two boys and two girls, based not only on their grade level and status as an African American, but also on teacher recommendation for students with a variety of backgrounds who could articulate their ideas in a conversation (Miles, Huberman, & Saldaña, 2014). Achievement levels were not considered for two reasons: overly emphasizing external validation and lack of standardized assessment. As the definition of mathematics identity previously presented discusses, a person's mathematics identity is comprised of their ability to do math, their value of math, and their motivation to improve their knowledge in math (Martin, 2000). Grades are one way these are communicated; however, as discussed in the findings, they do not always align with students' views of themselves. Thus, a range of achievement as measured by grades was not considered. The lack of standardized assessment is another way students receive external validation about their status as members of the mathematics community. As these assessments began at the end of third grade for students at Wildcat Academy, no information was available about these students' ability to complete a standardized assessment.

Of the four students identified, three students' parents/guardians provided consent and the three students, two girls and one boy, assented to participate in the study. All of the student participants in this study were 9 years old at the time of the study, indicating none had been promoted early or retained in any grade. This dissertation focuses on the experiences of two of the participants, Janae and Kayla. Delijah, the other participant, is purposefully not included in the manuscripts in this dissertation. While his experiences are interesting, he had very strong influences from his mother and home life. Thus, classroom influences are somewhat diminished as he regularly stated he was not learning during specific activities because he already knew the content. Due to my sense that there is a potential super rival explanation (Miles, Humberan, Saldaña, 2014) and to his emphasis on home influences that were outside of the purview of the research questions, his experiences are not reported here.

Janae was a 9 year old female in the class. She lived with her mother and sisters who were major influences on her life. Janae was the youngest member of her household. Throughout our conversations, Janae consistently articulated her value of hard work. In the classroom, she was a hard worker but a more reserved student in her interactions with the class and with her peers. In Ms. Madison's classroom, this positioned Janae positively and she excelled.

Kayla was a 9 year old female in the class. She also lived with her mother and sisters. Her mother was very active in the school, serving as a cheerleading sponsor. Kayla was the middle child of three girls. Similarly to Janae, Kayla consistently articulated the importance of hard work in the mathematics classroom. However, she did not always show her hard work. Ms. Madison's norms positioned Kayla as outside of the mainstream in the classroom. As discussed later in this dissertation, Kayla's struggle to claim a positive position in the classroom played an important role in her mathematics identity development. While Kayla thrived when given titles of importance, she also needed consistent praise and struggled regularly. Kayla's attendance was also inconsistent toward the end of the study.

Ms. Madison, the classroom teacher, also gave consent to participate and was interviewed. Ms. Madison was in her fifth year teaching. At the time of conducting this study, she had taught in two states and focused on urban schools. As an African American female, she initially attended Spelman College before earning her elementary education degree through a traditional college of education. Even so Ms. Madison was recruited to Wildcat Academy due to her exceptional work in another school where her students posted the highest mathematics results in their charter network. Ms. Madison spent time building relationships with her students and other students throughout the school, serving as coaches to basketball and volleyball teams.

Data Collection

I gathered data using multiple strategies. Yin (2014) recommended four principles in data collection: use multiple sources of evidence; create a case study database; maintain a chain of evidence; and, exercise care when using data from electronic sources. I used multiple sources of evidence as a way to increase the construct validity of the study. I chose to use prior documentation of progress, a brief mathematics questionnaire, interviews, stationary video, student participant video, and digital artifacts of student work as sources of evidence in this study.

First, the three student participants were given a brief qualitative questionnaire to gauge their attitudes about mathematics (See Appendix A). I completed this step of data collection in April. Thus, routines and norms in the classroom were firmly in place by this time. This questionnaire was developed by Whitin (2007) and published in *Teaching Children Mathematics*. The purpose of the questionnaire was to gain background information about how each participant views mathematics and to begin to highlight what each participant viewed as important in mathematics. For example, the questionnaire included prompts about when math is hard, when math is easy, and what students do when they do not know how to solve a problem. By gathering these ideas first, I was able to refer to them during the first interview for further clarification.

Second, stationary video and field notes were taken during all classroom observations. The stationary video was primarily focused on the whiteboard and SMART Board so that instruction was clearly captured. On days when students tested or worked on computers, the video focused on the student participants. Third, each student wore glasses with an embedded camera during observations. The videos were used to help focus on what individual students attended to during the lesson while still gaining an understanding of what happened in the broader classroom around the student participants. Moreover, the videos were used as discussion starters during the student participant stimulated recall interviews. Ultimately, twenty-eight hours of participant video was collected in addition to the fifteen hours of stationary video.

Finally, each student participant participated in three semi-structured interviews that were audio recorded (Patton, 2002), following the three-interview series model (Seidman, 2013). Interview protocols (See Appendix B) were designed to explore ways in which students learned about mathematics, related to mathematics, and conceptualized what was happening in the classroom. Initial interviews lasted between 30 and 45 minutes. The second interview utilized stimulated recall. Stimulated recall interviews required me to replay video clips to stimulate a discussion on the students' experiences and thoughts (Lyle, 2003). I used this method as a way to have students explain what happened in the classroom while also privileging their voices through their explanations. The stimulated recall interviews lasted between 25 and 45 minutes. The final interview focused on the big ideas that emerged throughout the data collection. Questions related to strategies, activities, and roles in the classroom were discussed. Each final interview lasted 35 to 45 minutes. The classroom teacher also participated in an audio recorded interview to provide her clinical expertise regarding her students and to provide insight into her approach to teaching mathematics. Her interview lasted just over 60 minutes. I transcribed all interviews verbatim. The interviews resulted in 6 hours of audio recorded data.

Data Analysis

Data analysis was an ongoing process throughout the study. Unfortunately, there are no set formulas or recipes for case study evidence analysis (Yin, 2014). My early analysis was based on the previously identified propositions of pedagogy, positionality, and space of authoring. This was consistent with Yin's (20140 suggestion of relying on theoretical propositions. Provisional codes were initially developed based on the extant literature (Miles, Huberman, & Saldaña, 2014). The provisional codes were codes developed before data were collected based on the propositions I identified when designing the study. In other words, these codes highlighted concepts and ideas that I thought would be important based on the theoretical framework and extant literature. These codes informed initial analysis. As I transcribed interviews, I began using descriptive codes and in vivo codes to further my analysis. In vivo codes are codes developed using the words of the participants. In this study, the ideas of "trying," practice," and "focus" continued to come up as I read through the transcripts. Thus, I used them as codes. Descriptive codes summarizes data with a word or short phrase (Miles, Huberman, & Saldaña, 2014).

First cycle coding continued throughout the interview process. Interviews were transcribed after they were completed. I transcribed each interview verbatim. I later went back to remove idiosyncrasies in speech, such as "ums." However, I left pauses in the transcripts. As I memoed throughout the process, I reflected on the pauses as potential

Table 3.1

First Cycle Coding

Code	Explanation	Code Type
Positive experience	Indication of a positive experience related to mathematics	Provisional
Negative experience	Indication of a negative experience related to mathematics	Provisional
Doing mathematics	Action or description is consistent with Van de Walle's notion of "doing" mathematics	Provisional
Receiver	Position offered to student in classroom as a receiver of information	Provisional
Instrumental understanding	Action or description is consistent with Skemp's idea of rules without reason	Provisional
Relational understanding	Action or description is consistent with Skemp's idea of making connections between concepts and/or being flexible in approach	Provisional
Ability belief +	Indication of a positive belief in participants' ability in mathematics	Provisional
Ability belief -	Indiciation of a negative belief in participants' ability in mathematics	Provisional
Extrinsic recognition	Indication of external communication through grades, test scores, or teacher feedback that influences thinking about ability	Provisional
Trying	Indication of importance of persistence	In Vivo
Find another way	Student describes or shows a different way to try to solve a problem or to check work	In Vivo
Focus	Student describes or shows importance of paying attention, usually the teacher	In Vivo
Practice	Student describes importance of practice	In Vivo
SMP	Student or activity discusses or highlights one of the Standards for Mathematical Practice	Descriptive
Growth Mindset	Action or description emphasizing the importance of hard work, perseverance, and help from others	Descriptive
Fixed Mindset	Action or description emphasizing natural ability as an explanation for level of math understanding	Descriptive
Problem Solving	Action or description of task that requires problem solving (understand, plan, try, reflect)	Descriptive
Teaching Strategy	Description of pedagogy (either positively or negatively)	Descriptive
Positive Interaction	Description of positive positioning with teacher, peer, or content	Descriptive
Negative Interaction	Description of negative positioning with teacher, peer, or content	Descriptive

areas of hesitancy, lack of understanding of the question, or as thoughtful responses. Thus, I left the pauses in the transcripts as a way to reflect on alternative explanations and my positionality as the researcher.

Completed interviews informed the next round of interviews (Seidman, 2013). For example, when the ideas of hard work and trying were identified as important in the first interview, I asked about those concepts in the second interview. Participants could then explain what they meant by hard work in specific instances from the classroom. econd cycle coding was used to condense data into patterns, which is a way to generate meaning (Miles, Huberman, & Saldaña, 2014). To generate meaning, I used several tactics suggested by Miles, Huberman, and Saldaña (2014). For example, I used noting patterns and pattern matching in the coding process. As I read the interview transcripts, there was a repeated emphasis on hard work. This pattern was noted and turned into a code to help condense large chunks of data that focused on the idea of hard work. Similarly, pattern matching was used to link ideas established in the propositions to what I saw in the data, specifically in terms of pedagogy, positionality, and space of authoring. I used provisional codes to begin the process of pattern matching. Table 3.2 shows patterns that formed from initial analysis.

I also used clustering by grouping and conceptualizing objects that have similar patterns or characteristics. For example, I used how the teacher positioned students in the mathematics classroom based her norms. Students' behaviors were then clustered as meeting the norms or not meeting the norms. I also used clustering to help identify different manifestations of perseverance in the video data. Participants' actions, such as talking through the problem, re-reading, asking for help, or giving up, were clustered into a category of manifestations of perseverance.

Table 3.2

Second Cycle Coding

Pattern	Associated codes
Explicit Focus on SMPs is Positive	SMPs, trying, find another way, problem solving, teaching strategy, positive interaction, doing mathematics, relational understanding
Growth Mindset Important	Growth mindset, trying, negative experience, negative interaction, positive interaction, ability belief +, extrinsic recognition
Importance of Positioning	Positive experience, negative experience, receiver, doing mathematics, positive interaction, negative interaction, teaching strategy

I also used partitioning variables as an analytic tactic. The ideas of hard work and perseverance consistently arose in the data. However, I also noticed a focus on the Standards for Mathematical Practice and on ideas around growth mindset. Both of these ideas also focus on perseverance. Thus, what started as one code became many as I partitioned the meanings based on the context. To do this, I relied on making conceptual and theoretical coherence. For instance, perseverance as part of the Standards for Mathematical Practice focused more on pedagogy, whereas growth mindset was more of a student initiated idea.

I also used memoing as a reflective and as an analytical process to determine the content of the second and third interviews. The memoing was based not only on the ongoing analysis, but also on the field notes from classroom observations. My memos took on many forms. I used them to reflect on my position as the researcher, especially in terms of any biases I was bringing to my observations and analysis. For example, I questioned whether or not my interpretation of Kayla's actions were fair to her and to Ms.

Madison based on my viewing. Based on these ideas, in our stimulated recall interview I made sure to ask Kayla about specific instances where I thought her perspective could confirm or deny my interpretation of the my observations. In this case, the videos worked with the interviews to provided another way to confirm the emerging patterns and themes.

Throughout the analysis process, I ensured participants' information remained confidential in order to prevent any potential harm in their relationships with parents and teachers that may come from participants sharing their perspective (Drew, Hardman, & Hosp, 2008). I incorporated the student perspective through stimulated recall and reiterated the emerging ideas in the final interview. This allowed for the student participants to provide input into my understanding of their experiences so I could reduce my bias as a white adult (Helms et al., 2006; Hopkins, 2013).

I focused on four primary methods to increase trustworthiness. First, I checked for researcher effects in three ways. I remained on site for as long as possible. This was particularly easy as I was a teacher at the school. However, I also had to balance that with spreading out site visits to avoid going native (Miles, Huberman, & Saldaña, 2014). Thus, the classroom observations occurred over the course of ten weeks in the third and fourth quarters of the school year. Also, when I interacted with the participants, my intentions were clear about conducting research.

A second way I ensured trustworthiness was through triangulation. I triangulated the data sources by including multiple people and times. I triangulated the method of data generation. I did not rely on only one type of data; instead, I used multiple observations and interviews to generate data. I also used different types of data, from the qualitative texts generated by the student questionnaires to the audio and video recordings.

I used looking for negative evidence as a third way to increase trustworthiness. While I used this throughout, it was especially true in Janae's case. She had such a positive experience in her mathematics class that I made a point to repeatedly review the data for possible alternative explanations. Finally, I used member checking with the teacher participant. I asked her to read the manuscripts to ensure plausible findings from the experiences in her classroom. These practices helped to increase the trustworthiness of this study (Miles, Huberman, & Saldaña, 2014; Patton, 2002).

Summary

A case study approach was used in this qualitative study to investigate the phenomenon of third grade African American learner's mathematics classroom experiences. In designing the study, I incorporated multiple sources of evidence including four video sources and a three series interview (Seidman, 2013) with each of the student participants. The classroom teacher was also interviewed. Data analysis was ongoing throughout the process through both coding and memoing. Steps were taken to increase the validity of the study by triangulating the data, member checking, and reducing researcher bias through participant feedback during the stimulated recall interview. Chapter 4 presents the findings in the form of two manuscripts.

Chapter 4

Perseverance, precision, and mathematics identity: Janae's experiences learning mathematics in a third grade classroom

Abstract

Students' mathematics identity has become more prominent in the research literature (Jackson & Wilson, 2012). The experiences of African Americans are still underreported, with African American elementary students receiving the least attention. This case study focuses on one third grade African America learner's experiences in a third grade classroom. Janae's experiences in lessons about fractions highlight the importance of the Standards for Mathematical Practice. In both the classroom and in interviews, she shows the importance of two Standards for Mathematical Practices in particular: *making sense of problems and persevering in solving them*, and *attending to precision*. Her experience suggests an emphasis on the Standards for Mathematical Practice contribute to more positive mathematics identities and to deeper content understandings.

Introduction

Third grade is a change year for most students in public schools. It represents a shift from primary to intermediate content and expectations. In terms of content, the Common Core State Standards for Mathematics begin to shift from counting, addition, subtraction, and place value with primarily whole numbers to multiplication, division, and fractions (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Students have had at least three years to begin to understand the process of schooling by the time they reach third grade. Most students receive messages about the type of student they are in a variety of forms while in primary grades. They receive feedback from teachers, parents, and peers. They also receive formal updates on their progress through report cards. In many locations, and at Wildcat Academy, where this study took place, the report cards for primary students look different than they do for intermediate students. It focuses on satisfactory and unsatisfactory markings instead of traditional letter grades.

Third grade at Wildcat Academy changes that. Check pluses, checks, and check minuses suddenly become average scores, numbers, and letter grades. It is also in third grade where they are met with more pressure and first face the omnipresent standardized assessment. In a school that has been labeled failing by the state, this usually means an increase in assessment so student progress can be monitored on interim benchmark assessments throughout the semester. While district and building adults are monitoring students' progress, students are also getting feedback about where they fall on the proficiency continuum. Before long, students are being labeled. In "failing" schools, administrators, teachers, and students all begin to share in the failure label.

Unfortunately, this system ignores the many success stories. At Wildcat Academy, an urban, predominantly African American school, Ms. Madison's third grade mathematics classroom is full of academically successful African American students. Instead of experiencing mathematics as a gatekeeper subject (Martin, Gholson, & Leonard, 2013), Ms. Madison and her students work hard to master mathematics and make it meaningful to their daily lives. One student in particular, Janae, stands out for her ability to persevere in the classroom.

Throughout several lessons on fractions, Janae engaged with the work and internalized the messages Ms. Madison provided during her instruction. Whereas most students struggle with applying whole number concepts to fractions (Newstead & Murray, 1998), Janae was able to explain them with precise communication and using a variety of representations. In this case study, I examine how Janae's experiences in Ms. Madison's mathematics classroom influenced her positive mathematics identity. Before exploring Janae's experiences, a brief review of relevant literature is needed.

Literature Review

Standards for Mathematical Practice

The Common Core State Standards for Mathematics can be separated into content standards, Standards for Mathematics Content, and process standards, Standards for Mathematical Practice (SMPs). Table 4.1 lists the SMPs. The SMPs have their basis in NCTM's (2000) *Principles and Standards for School Mathematics* in which they identify the process standards as problem solving, reasoning and proof, communication, connections, and representation. The SMPs vary from the content standards in two distinct ways. First, they remain constant in all grade levels. The SMPs are processes that can be used in any mathematical situation, unlike content standards which progress in complexity and difficulty. Second, they do not dictate the content, but rather offer ways to engage students through mathematics instruction (Bostic & Matney, 2014).

A shift in teaching must occur when implementing the Common Core State Standards for Mathematics (NCTM, 2014). As the SMPs are more practice based instead of easily measurable through standardized tests, there is a chance teachers view the SMPs as ancillary materials instead of equal parts of the standards. This can lead to using them as simply another mandate to complete, without full implementation (Russell, 2012). However, taken as whole, the SMPs can be seen as related skills and ways of approaching mathematics instead of a list of eight separate standards that should be developed in students (Pilgrim, 2014).

Table 4.1

Standards for Mathematical Practice

SMP	Related Actions
(1) Make sense of problems and persevere in solving them.	Explain the meaning of the problem Look for relationships Create a plan to solve Use multiple ways to check answer
(2) Reason abstractly and quantitatively.	Ability to decontextualize Ability to contextualize Using properties flexibly
(3) Construct viable arguments and critique the reasoning of others.	Use definitions and prior answers when making an argument Justify responses Ask questions of others' arguments
(4) Model with mathematics.	Apply mathematics to real world situations Reviewing model to determine if it makes sense in the context Improving model if it does not work as intended
(5) Use appropriate tools strategically.	Understand which tools are helpful for which task Understand when to use technology as a tool
(6) Attend to precision.	Communicate precisely with clear definitions Precise with units and symbols Calculations are accurate and efficient
(7) Look for and make use of structure.	Identify and use patterns Can think proceptually
(8) Look for and express regularity in repeated reasoning.	Identify shortcuts and repeated operations Evaluate results as solving to ensure they are on the right track

Mathematics Identity

Martin (2000) defines mathematics identity as “the participants’ beliefs about (a) their ability to perform in mathematical contexts, (b) the instrumental importance of mathematical knowledge, (c) constraints and opportunities in mathematical contexts, and (d) the resulting motivations and strategies used to obtain mathematics knowledge” (p. 19). Martin’s study resulted in a four-level framework—sociohistorical, community, school, and individual—which he considers relevant to African American mathematics identity generation and regeneration. At the sociohistorical level, Martin (2000) emphasized the historically discriminatory practices and procedures that disallowed African Americans from becoming full participants in many areas of society, including in mathematics. This sociohistorical level impacts the community level. As Martin (2000) explained, parents and other community members communicate about the importance of unimportance of mathematics to children. The children internalize the messages they receive which influences the way the (re)create their mathematics identities in the mathematics classroom. The mathematics classroom is located in the school level of the framework. At this level, Martin focuses on the norms of the school and classroom, the teacher’s beliefs and instructional practices, and the curriculum. In the fourth level, individual agency, Martin focuses on students’ perceptions of knowing and doing mathematics. Specifically, he identifies students’ abilities to focus on the big picture of mathematics learning in terms of their goals and the agency they need to reach their goals as key factors of success (Martin, 2000).

Around the same time, Boaler and Greeno (2000) described a connection between pedagogical style of the teacher and students’ development of mathematics identities.

Specifically, students in traditional AP Calculus classrooms “experienced an important conflict between the practices in which they engaged, and their developing identities as people” (Boaler, 2002, p. 44). When this conflict existed, students were more likely to not pursue mathematics further. In classrooms that focused more on discussion and participation, students “described their participation in active terms that were not inconsistent with the identities they were developing in the rest of their lives” (Boaler, 2002, p. 45).

These studies are foundational pieces for linking pedagogy and mathematics identity and defining mathematics identity; however, limited research has been conducted in the elementary classroom. Hodge (2008) examined students’ roles in different elementary classrooms. She followed eight students, seven White and one African American, in an affluent school over the course of their first and second grade years. Her results were not completely conclusive as to whether students were forming mathematics identities or trying to please their teachers.

Important in the concept of mathematics identity is the idea that it does not form in isolation of other identities. While explained more through the theoretical framework, Martin (2007) noted:

> Because mathematics is only one aspect of a person’s life, mathematics identities do not develop in isolation from the other identities that people construct (e.g., racial, cultural, ethnic, gender, occupational, academic). For some individuals, these multiple identities may unfold in ways that make them incongruous... For others, there may be explicit attempts to merge these identities so that they exist

> in unison. Any challenge or affront to one is then interpreted as a challenge to others. (p. 151)

Thus, as I turn to the theoretical framework, an emphasis on multiple identities being possessed and generated at the same time is an important concept.

Theoretical Framework

Figured worlds focuses on how people participate in socially and culturally constructed contexts (Holland, Lachiotte, Skinner, & Cain, 1998). This theory is largely based upon the work of Vygotsky and Bakhtin (Holland et al., 1998; Urrieta, 2007). Vygotsky emphasized individual development through social interactions. When applied to a learning situation, this leads to the zone of proximal development, an area one is cognitively ready to explore, but needs the help and social interaction of a more experienced other to support emerging understandings (Vygotsky, 1978). Symbols mediate the social interactions and impact self-formation. When interacting in a specific context (i.e., a third grade mathematics classroom), symbols help organize individuals' activities (Penuel & Wertsch, 1995). Using the symbols and artifacts to organize themselves allows individuals to impart meanings onto themselves and onto their interactions with others (Penuel & Wertsch, 1995).

Bakhtin (1981) contributed ideas related to authoring and dialogism. In short, Bakhtin (1981) argued the world must be answered. In this view, thoughts occur because of or in anticipation of social interaction. One can then produce meaning through dialogue (Holland et al., 1998). Dialogism also suggests people can hold contrasting thoughts at the same time (Bakhtin, 1981). Instead of one idea gaining an ongoing advantage, the dialogic process allows various ways of authoring to exist, with ideas gaining and losing advantage depending on the context. Thus, how one authors identity in a given context depends on the interactions with others in a given context (Holland et al., 1998).

Based on these theories, identities are produced over time, through interactions, and within a specific place (Holland et al., 1998). These specific places are called figured worlds. How individuals perceive the figured worlds can impact the figured worlds and the identities individuals create and recreate. Moreover, the ways individuals interact within the figured worlds are partly due to their experiences in other figured worlds, partly independent of these experiences, and due to outside forces (Holland et al., 1998). Thus, because each individual enters figured worlds with different experiences and experiences the figured worlds differently, identity development in figured worlds emphasizes the interactions within the figured world (Urrieta, 2007).

Three contexts are important for identity formation in figured worlds: positionality, spaces for authoring, and world making (Holland et al., 1998). Positionality focuses on issues of power, privilege, and how an individual views oneself in relation to belonging in the figured world. In a classroom, such positions could be good student, class clown, or talkative student, for example. Social categories (i.e., gender, class, and race) of individuals in figured worlds can create opportunities or barriers. Individuals must accept, reject, or negotiate the identities being offered to them in the figured world (Holland et al., 1998).

Space of authoring is based on Bakhtin's dialogism. The contrasting ideas individuals hold at the same time help shape their responses to the positions they are offered in a figured world. Holland et al. (1998) argued while novices in the figured world may accept the position offered by a more powerful figure, a more seasoned person might take the opportunity to shape worlds differently. How the individual decides to respond is a choice: accept, reject or negotiate; however, deciding not to respond is also considered a response (Urrieta, 2007). How students are positioned and position themselves and how they author their identities are important considerations when examining how Janae's experiences in the figured world of the third grade mathematics classroom shaped her mathematics identity.

Method

Qualitative methods were used to explore classroom influences on the development of Janae's mathematics identity. Specifically, I used a case study approach to explore the phenomenon of mathematics identities in the elementary classroom so that student voice is prioritized (Nieto, 1992) and to create a more complete picture of an individual's experiences (Berk, 2006). This paper presents the experiences of one female participant, Janae, a pseudonym, in a third grade mathematics classroom in a large urban school in the United States.

The School & Classroom

The site of the research was Wildcat Academy, a pseudonym. Wildcat Academy was a large urban school in the Midwest United States serving nearly 900 students in grades prekindergarten through eight. The school had persistently been labeled a failing school in terms of achievement performance by the state. Each grade level in kindergarten through sixth grade had three teachers, with four teachers per grade in seventh and eighth grades. Each classroom served 25 to 30 students, with the average being 28 students per classroom. In addition to the regular classroom, the school employed a cadre of resource teachers that ranged from music to physical education to creative writing. I served as a STEM resource teacher. Figure 4.1 displays the racial composition of the teachers and administrators at the time this study was conducted.

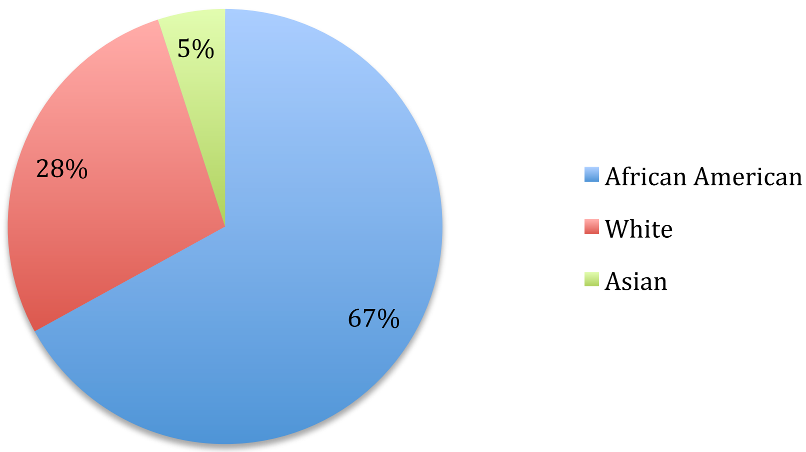


Figure 4.1. Racial composition of the teaching staff at Wildcat Academy.

The third grade teaching team consisted of three teachers. The administration organized the team to be departmentalized, a process in which each teacher specialized in one subject area. One teacher taught reading and writing. Another teacher taught science and social studies. The third team member, Ms. Madison, a pseudonym, taught mathematics. This study took place in Ms. Madison's classroom where she used the district mandated curriculum, *Engage NY*.

A typical class was segmented into four distinct segments: fluency, concept work, application, and assessment. The fluency segment lasted approximately fifteen minutes and consisted of a variety of practices for students to practice basic skills. Many days this focused on skip counting to reinforce relationships in multiplication and division. Ms. Madison used a variety of methods from student led skip counting to teacher led practice with skip counting. The concept work focused on the big ideas of the curriculum unit and lasted for approximately twenty minutes. For example, students partitioning a number line into fractional parts was part of a concept development around linear models of fractions. An application problem that took ten to fifteen minutes usually followed the concept development. This problem required students to use the concept just practiced or a closely related big idea. For example, in a geometry lesson on area, the application problem focused on composite shapes. Lessons usually ended with an assessment on a worksheet or exit ticket that lasted five to ten minutes. Some days were different, such as during a unit test or during computer work days. On computer work days students would log on to an adaptive learning system, ALEKS, and complete work on their level.

The students who attended Wildcat Academy were primarily neighborhood students. Only five buses served the school with many drops being within a three-mile radius. High levels of poverty and violent crime marked the neighborhood the school served. Accordingly, all students qualified for free and reduced lunch, a measure of poverty. Racially, the students were categorized[2] as predominantly African American with less than two percent of students being categorized as Asian, Hispanic, White, or other. Figure 4.2 displays the racial composition of the students attending Wildcat Academy at the time this study was conducted.

[2] I use the term “categorized” as I do not presume to know the race each student identified.

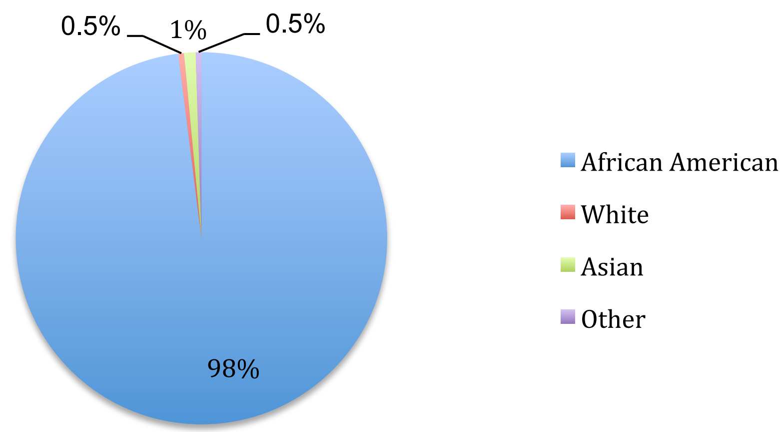


Figure 4.2. Racial composition of students at Wildcat Academy.

Participants

Reputational case selection was used to identify four African American third grade students, two boys and two girls, based not only on their grade level and status as an African American, but also on teacher recommendation for students with a variety of backgrounds who could articulate their ideas in a conversation (Miles, Huberman, & Saldaña, 2014). Three students' parents/guardians provided consent and the three students, two girls and one boy, assented to participate in the study. All of the student participants in this study were 9 years old at the time of the study, indicating none had been promoted early or retained in any grade.

Ms. Madison also gave consent to participate and was interviewed. Ms. Madison was in her fifth year teaching. At the time of conducting this study, she had taught in two states and focused on urban schools. As an African American female, she initially attended Spelman College before earning her elementary education degree through a traditional college of education. Even so Ms. Madison was recruited to Wildcat Academy due to her exceptional work in another school where her students posted the highest mathematics results in their charter network. Janae's experiences in Ms. Madison's classroom is the focus of this case study.

Data Collection

Data were generated using multiple strategies. First, the three student participants were given a brief qualitative questionnaire to gauge their attitudes about mathematics (See Appendix A). Second, stationary video and field notes were taken during all classroom observations. Third, each student wore glasses with an embedded camera during observations. The videos were used to help focus on what individual students attended to during the lesson while still gaining an understanding of what happened in the broader classroom around the student participants.

Finally, each student participant participated in three audio recorded semi-structured interviews, following the three-interview series model (Seidman, 2013). Interview protocols were designed to explore ways in which students learned about math, related to math, and conceptualized what was happening in the classroom. The second interview utilized stimulated recall as a way to have students explain what happened in the classroom while also privileging their voices. The classroom teacher also participated in an audio recorded interview provide her clinical expertise regarding her students.

Data Analysis

Data analysis was an ongoing process throughout the study. Provisional codes were initially developed based on the extant literature (Miles, Huberman, & Saldaña, 2014). Interviews were transcribed after they were completed. Moreover, completed interviews informed the next round of interviews (Seidman, 2013). When analyzing the corpus of data I used open coding to develop another round of codes past the provisional codes (Corbin & Strauss, 1990). I then used the provisional codes and those established from open coding to establish more codes, which were used to code the transcripts.

Memoing was used as a reflective process and as an analytical process to determine the content of the second and third interviews. The memoing was based not only on the ongoing analysis, but also on the field notes from classroom observations. The videos provided yet another source of data to visually confirm codes or to contradict emerging understandings. These multiple sources of data helped triangulate the analysis. After the coding was complete, I looked for common themes and any divergent cases by looking at different categories for any patterns (Miles, Humberman, & Saldaña, 2014).

Findings

As I examined the data in light of the research question regarding how third grade African American students generate mathematics identities based on their experiences in the mathematics classroom, three primary themes emerged from the data generated from Janae's experiences. The themes included perseverance and personal responsibility lead to success; the importance of the Standards for Mathematical Practice; and, positive positioning promotes positive mathematics identities.

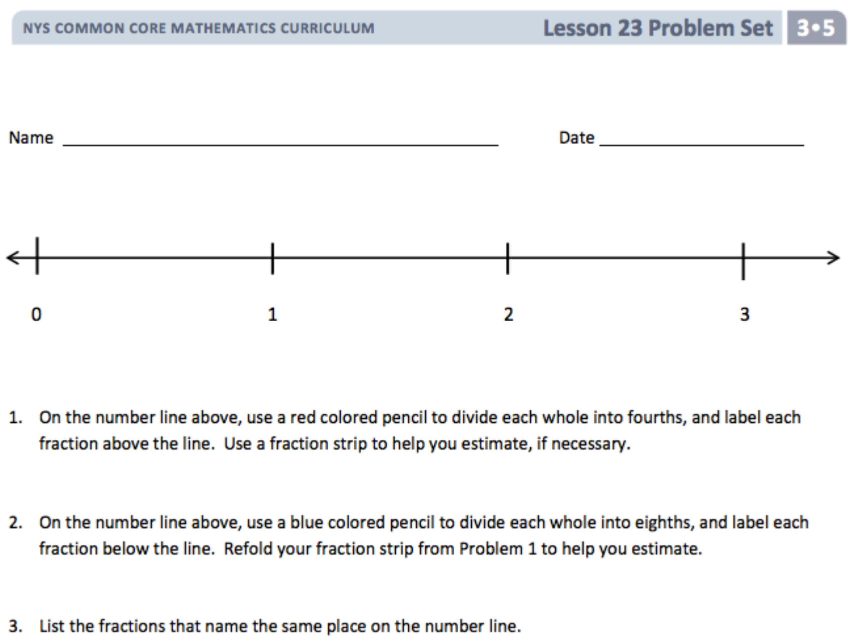
Perseverance and personal responsibility lead to success

Janae repeatedly explained and demonstrated the importance of persevering in mathematics. Perseverance took many forms for Janae. Specifically, the areas of practice, trying, and using available resources were ways Janae persevered in the mathematics classroom. According to her qualitative questionnaire, practice helped her be good in math because it provided an opportunity to learn from mistakes. If she was unsure of what to do, Janae focused on trying to figure it out because math became hard when she did not try. She explained this further in one of our conversations:

> I: What does working hard in [the mathematics classroom] look like?
>
> J: Like if something's hard and I don't understand it?
>
> I: Yeah. What do you do when you don't understand?
>
> J: I just I try to understand it.
>
> I: How?
>
> J: I try to solve it. Like try to solve it a different way than I tried to solve it my way.

Janae never hesitated when talking about the importance of trying. She also never mentioned giving up. Instead, if she tried to solve the problem on her own but could not, Janae asked for help from her teacher or classmates. Through Janae's emphasis on actively trying to solve problems, practicing her skills, and working hard in mathematics, she positioned herself as an active participant in the mathematics classroom. Persevering, as described in the first SMP, cannot be accomplished from a passive position. Instead, it requires the student to be engaged in applying her knowledge in search of a strategy that will lead to a solution that makes sense.

Janae did not just talk about the importance of persevering. She also showed it in the mathematics classroom. For example, Figure 4.3 is one of the tasks Janae completed in class. In this particular assignment, Janae had to partition the number line into fourths and eighths. Then she had to practice iterating the fractions as she labeled each position on the number line. While she did not struggle from zero to one (see Figure 4.4), she paused at twelve-eighths. She mumbled, "Ohhh I don't get it" to herself. After briefly looking around, she paused and appeared to be in thought. A few seconds later she reassures herself: “Okay I think I do. Okay I got it. I got it. Thirteen-eighths. Fourteen-eighths. Fifteen-eighths. Sixteen-eighths.” She continued filling in her number line as seen in Figure 4.5.


NYS COMMON CORE MATHEMATICS CURRICULUM — Lesson 23 Problem Set 3•5

Name ____________________ Date ____________

1. On the number line above, use a red colored pencil to divide each whole into fourths, and label each fraction above the line. Use a fraction strip to help you estimate, if necessary.

2. On the number line above, use a blue colored pencil to divide each whole into eighths, and label each fraction below the line. Refold your fraction strip from Problem 1 to help you estimate.

3. List the fractions that name the same place on the number line.

Figure 4.3. Fraction Number Line Task. This task required students to partition a number line and then iterate the individual pieces.

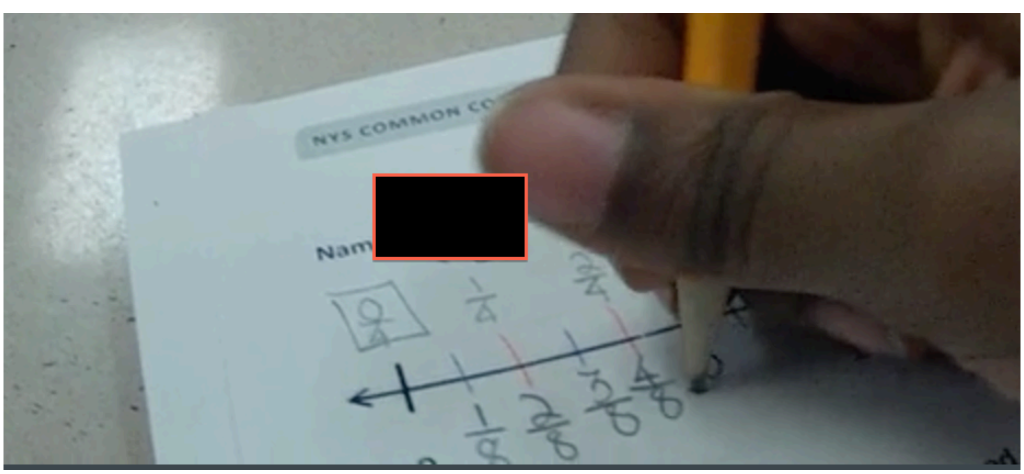


Figure 4.4. Janae worked on the fraction number line. Janae worked on the task before becoming confused.

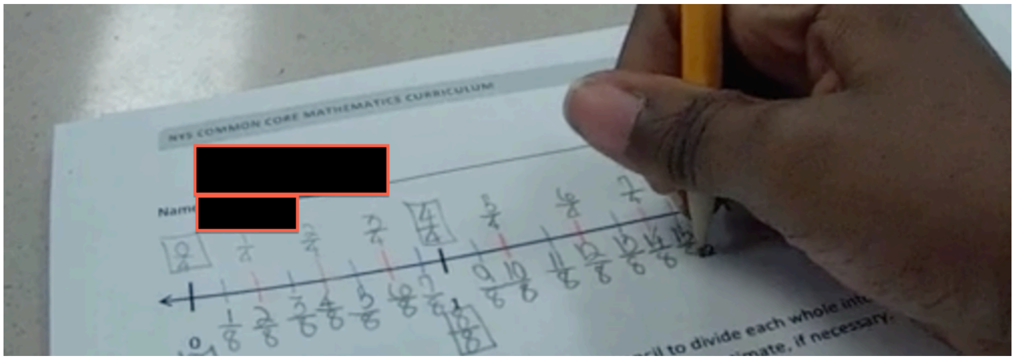


Figure 4.5. Janae persevered to complete the task. Janae models persevering in solving a problem as she completes the task.

Other tasks also required Janae to persevere in solving them. One characteristic that Janae repeatedly displayed was an ability to learn from her mistakes and she was solving problems. For example, in one class period, Janae worked on the computer. When the students worked on the computer they covered different topics as they used adaptive software. The topic for her that day was geometry. One problem set is seen in Figure 4.6. Janae was instructed to use the pictures to answer the following questions. The questions asked which figures are squares, parallelograms, and rectangles. Janae responded the first figure is a square, all three figures are parallelograms, and figures a and b are rectangles. Upon learning her third answer was wrong, Janae moved in closer to the screen. After careful examination, she decided options b and c are rectangles. Figure 4.7 shows the screen that appears. The message said, “Incorrect. Try reading the explanation first, then continue.” Janae looked to her notebook. She leaned in closer to examine the figures on the screen. Finally, after two minutes of attempting to solve the problem on her own, she turned to the student sitting beside her for assistance. After she received help from her friend, Janae answered the question correctly and moved on to the next problem with a smile on her face. Janae enjoyed being on the computer not because it was easy or a game; instead, she described the work on the computer as "hard." She liked it, though, "because it was challenging."

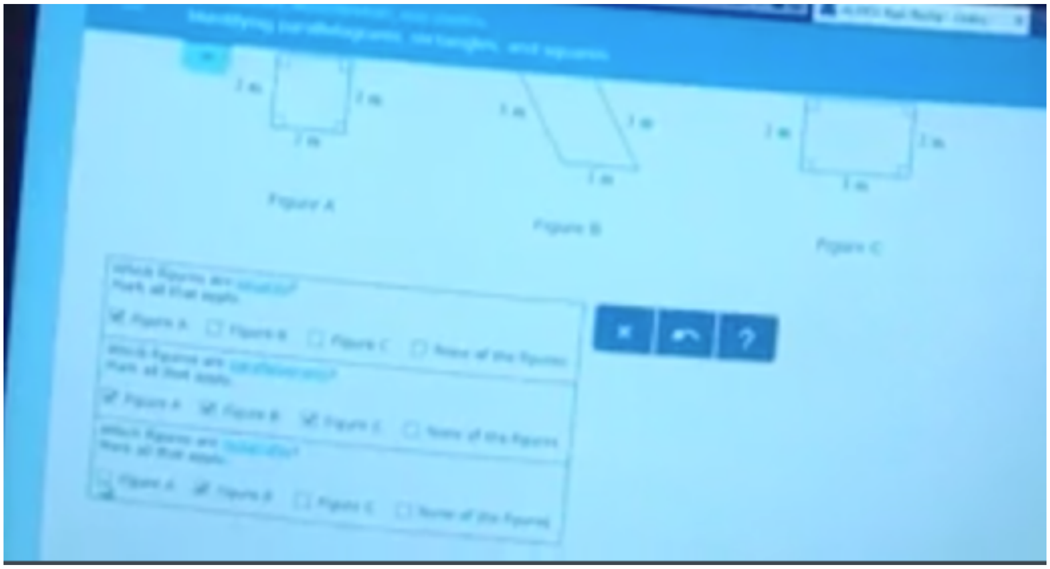


Figure 4.6. Geometry problem set on a computer. The questions ask students to distinguish between different types of parallelograms.

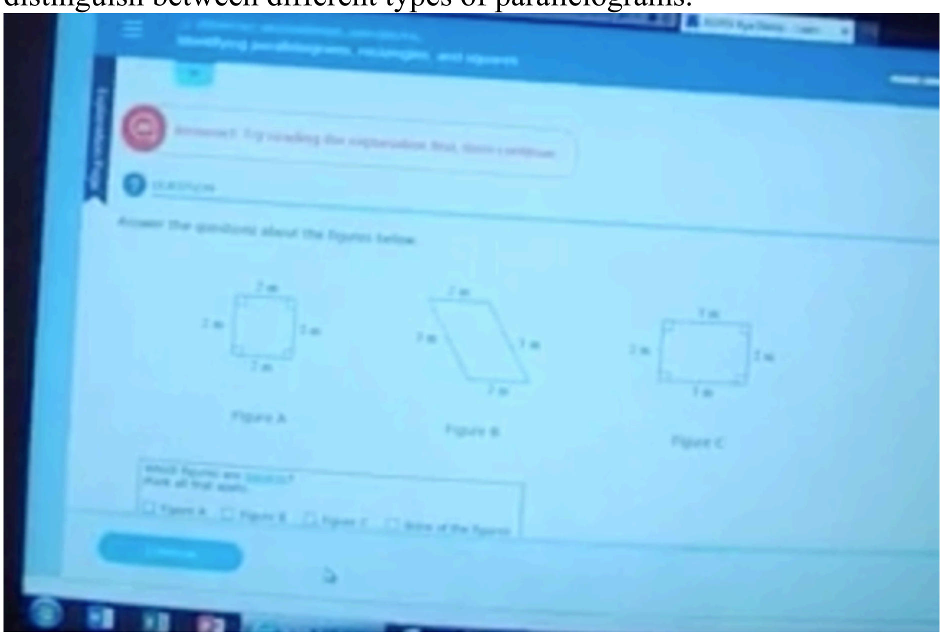


Figure 4.7. Janae got the wrong answer. Janae answered the question wrong and was prompted to read the explanation before trying again.

Janae's comments embodied the idea of productive struggle, which is extremely important in perseverance. In both examples Janae never appeared frustrated. That would lead to unproductive struggle; instead, she persevered to solve the problems. Even when she missed the problem on the computer two times, she did not give up. She tried to solve the problem by examining the shapes more closely, looking for different characteristics. When she missed the problem a second time, Janae still tried to solve the problem on her own until she relented and asked for help. These actions exemplified her words. When asked what she does when she has trouble solving a problem, Janae explained, "I try to do it if I can't ask for help." Throughout our conversations, the importance of trying and working hard continually arose. Her actions in the classroom confirmed her explanations. She did find success when she kept trying and working hard.

Her actions also hinted at a deeper idea at work. Janae's first reaction was not to immediately ask for help. Instead, she tried to solve problems using her own resources. In the computer problem, she reread, she examined the figures closely, and she attempted two answers before she asked for help. These actions also showed a sense of personal responsibility.

Janae took ownership of her learning in the classroom. While Ms. Madison and her classmates were there to help her when needed, she phrased success in the mathematics classroom in terms of her own actions. For Janae, "Math is hard when *I don't try*," but easy "when *I try*." She did not spend time talking about the role of others in her pursuit of being successful. Moreover, she was clear about what actions she felt were best for her in the classroom. When I asked Janae what classroom activities helped her learn mathematics best, she responded, "When Ms. Madison is up front talking [because] she explains it."

Janae also took personal responsibility in knowing her weaknesses. For example, group work was her least favorite activity in the mathematics classroom. As she explained,

> We get split up into groups of two or four. She puts questions on the screen and we, um, each group gets one question. We talk about it and solve it. But I want to work by myself. Sometimes we get distracted in groups.

In this exchange, Janae again showed her personal responsibility for her success in the classroom. She preferred learning from Ms. Madison and then getting help from her peers or Ms. Madison as needed. When she participated in group work, there was a chance for distraction as conversations moves away from the task at hand. Thus, Janae preferred to work by herself. Fortunately for Janae, this was the primary format of instruction in this classroom.

In these examples, Janae repeatedly highlighted the importance of persevering through trying and working hard. She took ownership of her success in the mathematics classroom. Her actions matched her explanations. This focus on perseverance lends itself to a closer examination of the Standards for Mathematical Practice at work in this classroom.

Importance of the Standards for Mathematical Practice

Ms. Madison's classroom prioritized the SMPs. She created a large display of the standards that was prominent in her classroom. Moreover, Ms. Madison did not treat the SMPs as just a checklist item (Russell, 2012). As Ms. Madison explained,

> As far as the mathematical practices, depending on the lesson, I don't always use all eight. But I will use making sense of the problems, persevering in solving them. We always use some type of tool… but again, that's kind of sketchy because tools some people relate to rulers as a tool but I say pencils are a tool because that's something you have to have… But it just depends on what the lesson is and what the lesson calls for.

When I asked about how she focused on the SMPs, Ms. Madison noted the explicit references she makes to the practices.

> We would look back at the standards and say that we're modeling with mathematics. And I try to point those out. Those are posted in the classroom. But I try to point those out to them so that they know this is something that I should be doing right now. I should be modeling with mathematics. So how am I making a model? Ok. This is what I'm doing to model mathematics. Even with modeling with mathematics or attending to precision. We use a rule to attend to precision. I would say we use a ruler to attend to precision. Make sure your ruler is straight. Make sure you're beginning at zero in order to create a number line that has equal placement or equal spaces. And all of these things again, I make references to it but it is also taught. Because in order to make a reference to something you have to have learned it… I learned how to use a ruler. My teacher told me that I use a ruler to attend to precision. And now I'm bringing it back to my remembrance to say okay I'm going to attend to precision because I'm using a ruler. So I think it works simultaneously.

Thus, in her classroom, she not only makes explicit references to the practices, she also takes time to teach students what those practices look like in action in her classroom. In any classroom time is a precious commodity. What teachers choose to spend time teaching and modeling sends clear messages about what is important in their classrooms. Thus, Ms. Madison's explicit focus on the SMPs communicates their importance in her mathematics classroom.

Janae understood the importance of the SMPs. The previous discussion on perseverance showed Janae exemplifying part of the first SMP, make sense of problems and persevere in solving them. She also took time to make sense of problems. For example, Janae's work in Figure 4.8 was not completed immediately. In her video, she consistently went back to read the directions before answering the problem. She read the directions aloud to herself. When she had drawn her model, she went back to the problem to make sure her answer made sense in the context of that problem.

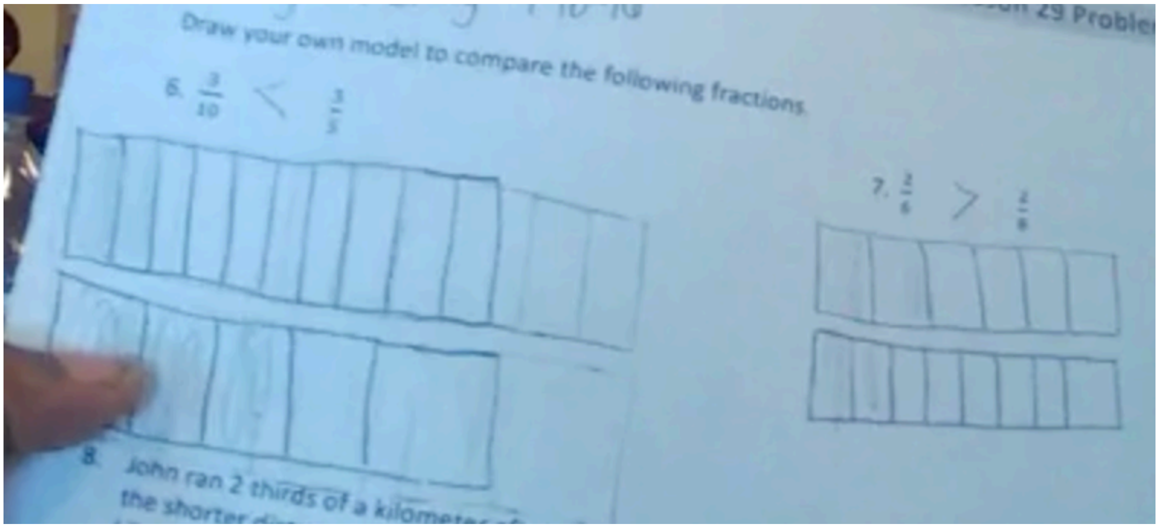


Figure 4.8. Janae made sense of problems. Janae examined her work to ensure her answer made sense.

Janae was able to implement and explain more than perseverance and making sense of problems, though. There were also clear cases of Janae attending to precision and using appropriate tools strategically. In my conversations and observations, these practices were most often displayed when focusing on fractions or area. For example, Janae described a performance task that happened on a day I did not observe the classroom. She explained,

> [The problem] was something like a teacher was watering a garden with a water hose. There was a twist in it one fourth of the way. And they asked us if the nozzle or the first part of it is closer to the twist… So we figured it out… We took words from the, from the question, and we put it in the answer to make a complete sentence. And it was like a number line on there and it asked us how far from the nozzle is the twist. And we counted to see, like one-fourth, two-fourths, three-fourths. Ms. Madison has a poster on her wall… Number 6, attend to precision… Ms. Madison says “attend to precision.” When we was doing fractions, putting fractions on a number line, she said try to get your number line straight and keep it even… That helped me understand it…by knowing what to do… If fractions are equal and they can’t be spaced out unequally.

In this example, Janae internalized the importance of attending precision, even recognizing it as the sixth SMP without any reminders around her. Janae not only explained how she attended to precision (making a number line straight and keeping it even), she also noted how being precise in her model helped her better understand fractions. Janae articulated how equal spacing is important because fractional parts are equal parts of a whole. Thus, using the practices helped Janae be successful in mathematics and she realized it.

Janae's experiences in this particular example positioned her positively in the classroom in two ways. First, she noted her own success. She was able to link the how she attended to precision to understanding fractions. Janae's realization of this link allowed her to demonstrate a better understanding of the content. In most classrooms, understanding the content is a trait of a successful student. Thus, she positioned herself positively by making the connection. The successful link allowed her to claim the label, or position, of good math student. However, Ms. Madison's explicit focus also helped her make this positive connection. As Ms. Madison emphasized the importance of the SMPs through her teaching and modeling, Janae internalized their importance and was able to articulate it. Thus, Janae also positioned herself positively by meeting Ms. Madison's expectations. The internal positioning related to her successful understanding was confirmed with Ms. Madison's consistent and explicit focus on the SMPs as important tools in her mathematics classroom.

Ms. Madison also focused on attending to precision when working on area. As seen in Figure 4.9, Ms. Madison labeled her answers to the area problem as square units. While she showed students multiple strategies, she continually included the square units, reminding students she was attending to precision. She also communicated the importance of using this practice to her class, specifically as it relates to correctness. As she reminded her students, “Your answer is not correct if you do not include the units. You have to attend to precision when you write your answer.”

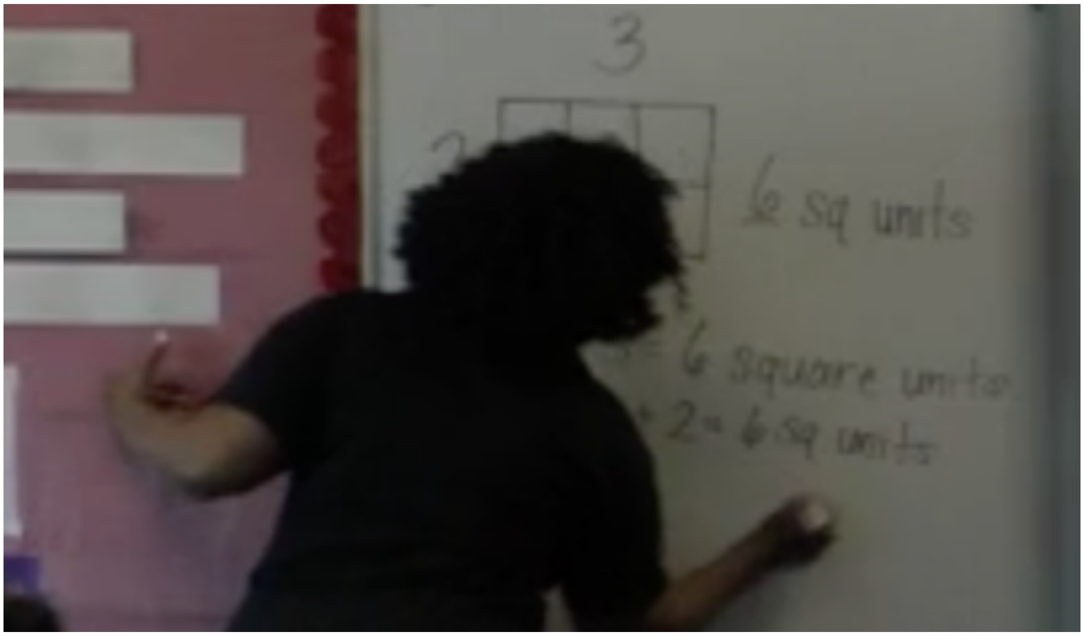


Figure 4.9. Ms. Madison emphasized attending to precision. Ms. Madison attended to precision in a lesson on area.

Janae internalized this message. As she worked on her area problems, she took pains to include square units. Figure 4.10 shows her work on some of these problems. What is most interesting about how Janae used and described the SMPs is how she was able to use the SMPs in a variety of ways. For example, when attending to precision, the fractions on a number line in Figure 4.5 show her attending to precision with equal parts of a whole. She verbally explained the importance of attending to precision as described above. Moreover, she attended to precision in her visual representations of area, too. This is evident in Figure 4.10. Janae took her time to painstakingly draw a precise area model with her ruler. She erased and redrew several times until it was precise enough for her. In this particular example, Janae also used appropriate tools strategically. While she was not measuring, she used the ruler to help her be precise.

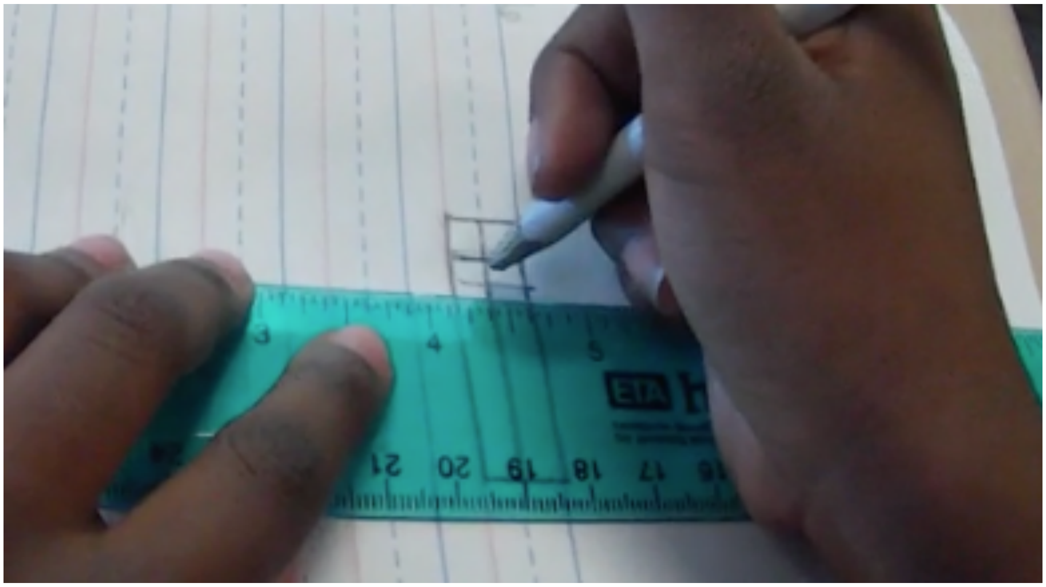


Figure 4.10. Janae attended to precision. Following Ms. Madison's example, Janae used a ruler to draw precise area models.

Throughout these examples, Janae internalized the importance of the SMPs and displayed an ability to use them flexibly and efficiently. She knew using a ruler could help her attend to precision, not just in measurement, but also when she is drawing a visual representation. The multiple ways Janae used the practices in action and communication, both verbal and written, demonstrates not only her proficiency with the practices, but also the importance of the practices to her experiences in the mathematics classroom. As Ms. Madison described, this was by design. With an explicit focus on the practices, Janae internalized them as another way to help her be successful in mathematics. As she explained, the mathematical practices "help me understand."

Positive positioning promotes positive mathematics identities

Janae was positioned in a variety of ways in the classroom. Remarkably, virtually all the positions she held were positive. Janae entered the classroom with a positive position as a good mathematics student. Janae had an affinity for mathematics, describing it as her favorite subject. Moreover, as Figure 4.11 shows, she not only associated mathematics with multiplication and division facts—relevant mathematics to her third grade experiences—but she also indicated the positive feelings she held for mathematics in her drawing. As she also explained, “I think I’m good [at math]… because I get A’s. And 100% or something between 90 and 100.” Thus, due partly to her past success that was communicated via grades, she entered the figured world of Ms. Madison’s third grade mathematics classroom with a positive mathematics identity.

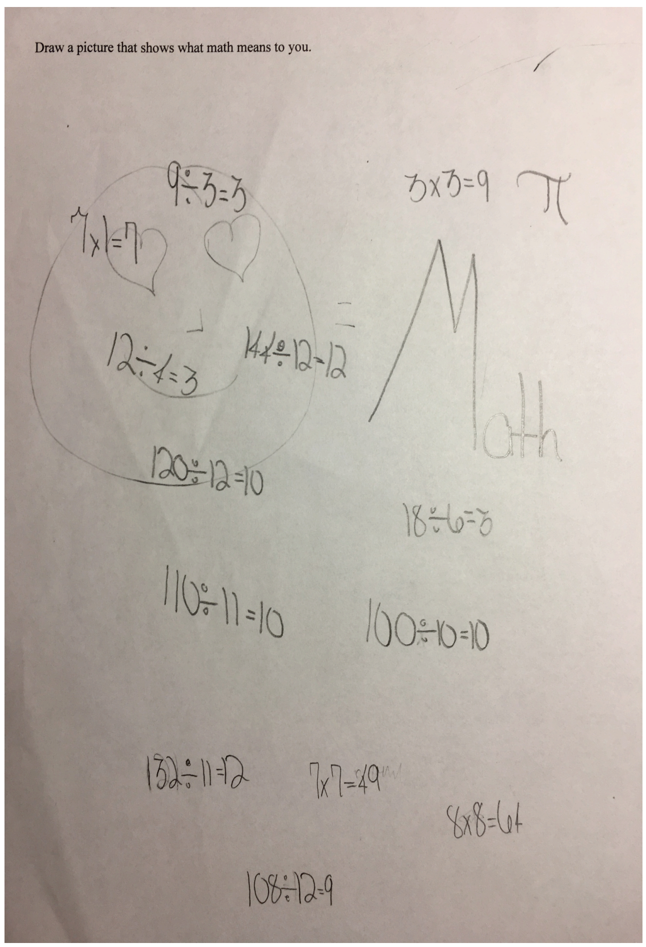


Figure 4.11. Janae drew what mathematics means to her. Janae drew a face with heart eyes and several mathematics symbols or procedures.

Janae’s commitment to perseverance also positioned her favorably in the classroom based on the norms established by Ms. Madison. She focused her time on practicing, trying, and working hard to understand the content. By positioning herself in this manner, she helped author her identity as a hard-working student. This also helped her with Ms. Madison. During our conversation, I asked Ms. Madison what it means to be a good mathematics student. She explained,

> A good student in math is a student who actually works diligently to solve problems. They persevere. They demonstrate grit. So if there is something that they don't understand they dig in anyway. They dig deeper. It's not the one who always makes straight A's. It's not that student. But it's the student that tries their best. It is the student that absorbs what you're trying to teach them, even after they didn't get it.

It was easy to see how Ms. Madison would view Janae as a good mathematics student, then. Ms. Madison valued effort and perseverance. Janae identified those skills as the keys to success in mathematics. As a large part of Janae's authored mathematics identity was built on perseverance, trying, and hard work, Ms. Madison viewed her positively. Ms. Madison's descriptions of and interactions with Janae showed how she positioned her positively.

Ms. Madison talked in-depth about each of the participants in the study. I asked her if Janae was a good mathematics student. She shared,

> I believe Janae is a good math student because Janae never gives up. Even though there are times where she gets frustrated, Janae will lean back in her seat and say 'Ok. I just don't get it.' And she will look at it and try to find the third way or find a different way to solve this problem. Or she may call on her classmates to help her or me for a little bit of support. But she never gives up. So as far as her being a good math student, definitely.

Her description was littered with praise for Janae. Ms. Madison's description positions Janae as a good mathematics student. Janae does not have to negotiate this position because it also aligns with the identity she has authored for herself in Ms. Madison's classroom and the mathematics identity she brought to Ms. Madison's classroom.

In addition to her descriptions, Ms. Madison also positioned Janae positively in two distinct ways, her interactions with Janae and the tasks she gave. Ms. Madison's interactions with Janae in the classroom were positive. For example, Figure 4.12 shows Janae's perspective as Ms. Madison approached to check her work. Ms. Madison looked at her work and quickly noted, "You have to put the eighths in blue… You did it. It's just light. That's cool." After the conversation, Janae quickly made her blue lines darker. However, the interaction positively reinforced Janae as being successful in the mathematics classroom.

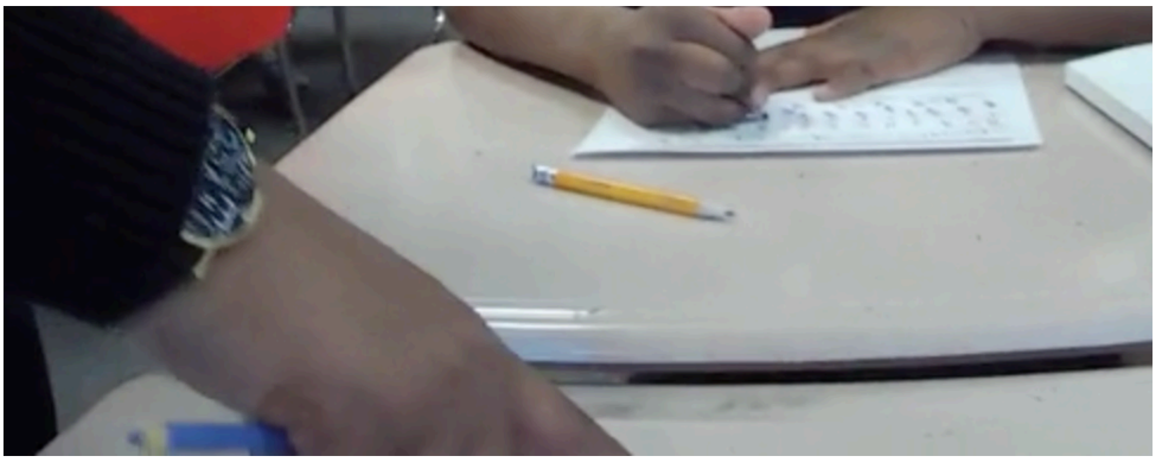


Figure 4.12. Ms. Madison checked Janae's work. The interaction with Ms. Madison positioned Janae positively.

The tasks Ms. Madison used in her classroom also helped to position Janae positively. Most tasks challenged Janae and allowed her to go back to her core mathematics identity as being successful because of hard work. In her performance task, she explained how she solved the problem. Even though she completed it with group members, Janae focused on the discussion as a way to solve the problem. The computer activities Janae used were also challenging. These tasks were not simple enough to click and get the right answer. Instead, Janae had to persevere to solve the problems, an example of which is described previously.

Two components of the task are important to how Janae was positioned. First, the tasks invited her to struggle productively. When she worked hard she could achieve the answer, even if she needed to get help from a classmate or the teacher. Thus, she never experienced frustration to the point of giving up. Second, most of the tasks also invited her to use multiple strategies. As Janae explained, when she did not understand something, "I try to solve it. Like try to solve it a different way than I tried to solve it my way." Algorithm practice worksheets do not lend themselves to this strategy as easily as the tasks Janae experienced in Ms. Madison's class do. The fractions on a number line task, the water hose task, and the shape question on the computer all invited Janae to use different strategies as she solved the problems.

Discussion and Conclusion

Janae's story represents one student's experiences in one elementary mathematics classroom in the United States. However, there are important lessons to be learned from her experiences. The explicit teaching and modeling of the SMPs made a key difference in Janae's understanding of mathematics and her relationship with mathematics. To Janae, understanding mathematics required perseverance and sense making. This is the essence of the first SMP. Throughout Janae's experiences in the third grade mathematics classroom, Ms. Madison consistently referred to the SMPs and explained their importance. Janae internalized these practices as she solved problems. For example, when attending to precision while partitioning a number line, Janae understood why she was doing this by explaining the marks on the number line needed to be equidistant as they represented equal parts of a whole. This not only embodied the essence of attending to precision, but it also showed a more complete understanding of fractions than many of her peers. Thus, in Janae's case, her teacher's emphasis on the SMPs helped her to internalize them as a way of doing mathematics successfully. As she successfully used the SMPs, she described her better understanding of the content, which lead her to continued success in mathematics. The continued success she experienced reinforced her positive mathematics identity and her position as a competent member of the mathematics community within that classroom.

Janae's experiences also offer insight into the roles positioning and authoring play in the generation of her mathematics identity. Based on previous success in mathematics classrooms as evidenced by her report card grades, Janae entered the figured world of Ms. Madison's mathematics classroom with a positive mathematics identity. Janae's belief that mathematics success resulted from hard work, practice, and trying was at the core of this identity. Ms. Madison's perspective of what makes a good mathematics student favored this belief. Thus, Janae's previously held mathematics identity never clashed with Ms. Madison's expectations. Instead, her belief in hard work was reinforced through her teacher's interactions.

Although mathematics identity has been explored in a variety of contexts (e.g., AP Calculus classes by Boaler & Greeno, 2000; Middle school and adult learners by Martin, 2000; elementary students by Hodge, 2008), researchers have generally not focused on African American elementary learners. Thus, a major implication of this study is mathematics identity is an important concept to consider as early as third grade. Several studies focus on adolescents' mathematics identities (e.g., Berry, 2008; Boaler and Greeno, 2000; Martin, 2000; Zavala, 2014). However, the elementary age group is largely ignored. Janae's actions and words clearly communicate a positive mathematics identity. Accordingly, a future direction for research should be how to support positive mathematics identity development as students, particularly underrepresented students like Janae, transition into more advanced mathematics at the upper elementary, middle, high school, and college levels.

A second implication of this study is the importance of explicit modeling of the Standards for Mathematical Practice. Janae internalized the importance of persevering and of attending to precision because her teacher repeatedly emphasized the importance. In the case of attending to precision, Janae made the connection between the practice and the fractions concept of equal parts of a whole. As the SMPs are often referred to as being how we do mathematics or as ways of being, more research is needed to explore relationships between students' exposure to and use of the SMPs and the development of their mathematics identities.

Comparing mathematics identities of two African American third graders: A case study

Abstract

This case study explores how two African American third grade students developed positive mathematics identities through interactions in their mathematics classroom. Findings suggest maintaining a growth mindset and responding to positions offered in the classroom are important considerations for developing positive mathematics identities. In this case study, one student is positioned more positively and consequently faces limited resistance in maintaining a positive mathematics identity. On the other hand, another student in the same classroom regularly rejects and renegotiates the positions offered to her as she strives for success and a positive mathematics identity.

Introduction

Success can build on previous success in the mathematics classroom. For example, Berry et al. (2011) noted mathematically successful African American middle school boys identified computational fluency by third grade as key to their success in middle school. As content increases in complexity and difficulty, the participants in the study linked the importance of understanding prior concepts to their current success. The two students profiled in this case study, Janae and Kayla, also have a history of success in mathematics. They identified their good grades as validation of their prior success. In third grade, though, the content was shifting from addition and subtraction to multiplication and division. Janae and Kayla were also introduced to fractions in third grade through the Common Core State Standards for Mathematics (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

At Wildcat Academy, Janae and Kayla were in the same third grade mathematics class. Both students were African Americans, had multiple siblings, and lived with their mothers. Both students were nine years old and had an affinity for mathematics, as shown in Figure 4.13. To continue to succeed in mathematics, Janae and Kayla believed “hard work” and “focus” were critical; however, Janae did not have to rely on hard work as much as Kayla. Kayla relied more on her growth mindset instead of her previous identity as being smart (Boaler, 2016).

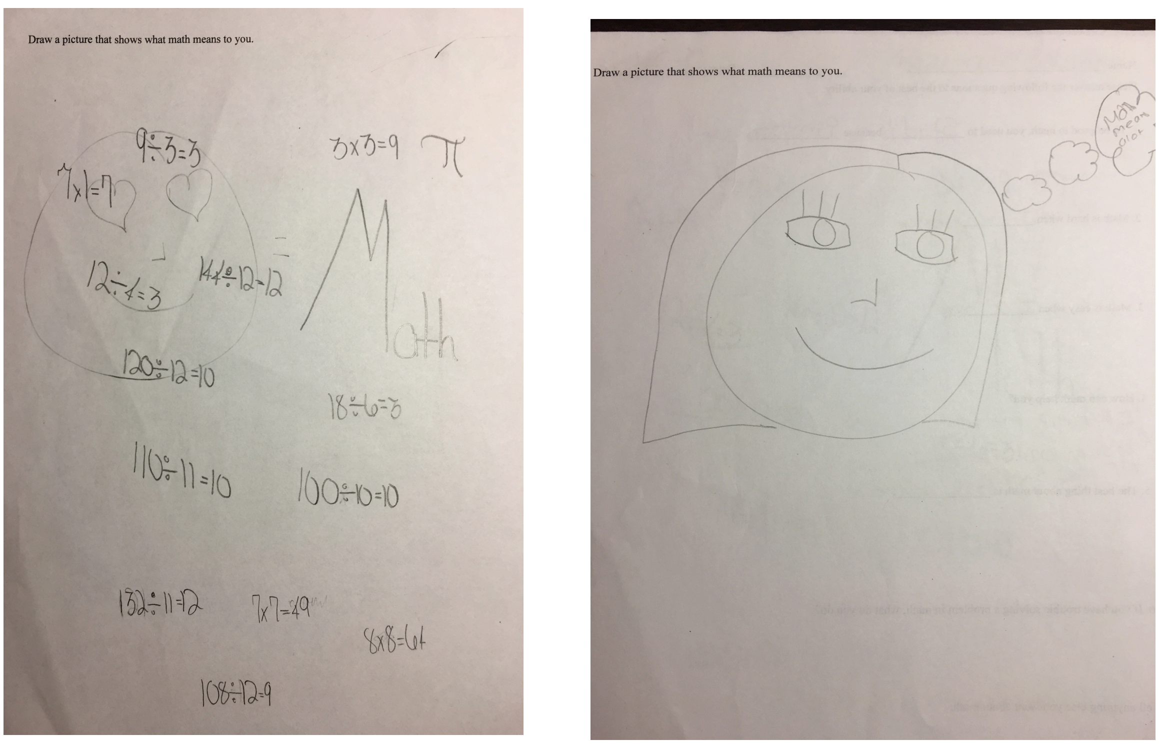


Figure 4.13. Janae (left) and Kayla (right) drew what mathematics means to them. Janae drew a face with heart eyes and several procedures, while Kayla’s drawing is of herself with a thought bubble that says “Math means a lot.”

While the students are similar in many ways, their experiences in Ms. Madison’s third grade mathematics classroom were quite different. The varied experiences caused Janae and Kayla to generate mathematics identities in very different ways. Although both students generated positive mathematics identities, Janae’s journey was much easier than

Kayla's. Kayla had to consistently fight for her place in the mathematics community. In this case study, I examine how Janae and Kayla experienced Ms. Madison's third grade mathematics classroom in drastically different ways while maintaining positive mathematics identities.

Literature Review

Growth Mindset

Dweck (2008) identified two types of mindsets, fixed and growth. In a fixed mindset, individuals believe intelligence is something one either has or does not have. In a growth mindset, individuals see intelligence as a changeable quality that can be developed through perseverance and practice. Traditionally, mathematics has been viewed as a realm for those with a "math brain," which exemplifies a fixed mindset (Boaler, 2016). Unfortunately, this concept is not just held by the general population, but also by mathematics professors at the post-secondary level (Leslie, Cimpian, Meyer, & Freeland, 2015). This has severe implications for students in these classrooms as the teachers determine who is capable not based on students' abilities and perseverance, but on their seemingly natural ability to correctly answer problems.

In the mathematics classroom, fixed mindsets pose other problems. Duckworth and Quinn (2009) found students with fixed mindsets are less likely to persevere in solving problems when compared to students with growth mindsets. Similarly, research has shown students with fixed mindsets achieve at relatively consistent levels, whereas students with growth mindsets tend to show more positive achievement gains (Blackwell, Trzesniewski, & Dweck, 2007).

Fixed mindsets have problems for those with what I will term a positive fixed mindset, too. Those individuals who believe they have a math brain or are naturally intelligent also suffer. As Boaler (2016) noted,

> It turns out that even believing you *are* smart—one of the fixed mindset messages—is damaging, as students with this fixed mindset are less willing to try more challenging work or subjects because they are afraid of slipping up and no longer being seen as smart. Students with a growth mindset take on hard work, and they view mistakes as a challenge and motivation to do more. The high incidence of fixed mindset thinking among girls is one reason that girls opt out of STEM subjects. (p. 7)

Especially relevant to this study is the growth mindset Janae and Kayla possess. They do not just believe in their abilities in mathematics, but they also believe hard work is critical for success.

Standards for Mathematical Practice

The Common Core State Standards for Mathematics can be separated into content standards, Standards for Mathematics Content, and process standards, Standards for Mathematical Practice (SMPs). Table 4.2 displays the SMPs along with related actions. The SMPs have their basis in NCTM's (2000) *Principles and Standards for School Mathematics* in which they identify the process standards as problem solving, reasoning and proof, communication, connections, and representation. Moreover, the SMPs vary from the content standards in two distinct ways. First, they remain constant in all grade levels. The SMPs are processes that can be used in any mathematical situation, where as the content varies by grade level and increases in complexity and difficulty. Second, they do not dictate the content, but rather offer ways to engage students through mathematics instruction (Bostic & Matney, 2014).

Table 4.2

Standards for Mathematical Practice

SMP	Related Actions
(1) Make sense of problems and persevere in solving them.	Explain the meaning of the problem Look for relationships Create a plan to solve Use multiple ways to check answer
(2) Reason abstractly and quantitatively.	Ability to decontextualize Ability to contextualize Using properties flexibly
(3) Construct viable arguments and critique the reasoning of others.	Use definitions and prior answers when making an argument Justify responses Ask questions of others' arguments
(4) Model with mathematics.	Apply mathematics to real world situations Reviewing model to determine if it makes sense in the context Improving model if it does not work as intended
(5) Use appropriate tools strategically.	Understand which tools are helpful for which task Understand when to use technology as a tool
(6) Attend to precision.	Communicate precisely with clear definitions Precise with units and symbols Calculations are accurate and efficient
(7) Look for and make use of structure.	Identify and use patterns Can think proceptually
(8) Look for and express regularity in repeated reasoning.	Identify shortcuts and repeated operations Evaluate results as solving to ensure they are on the right track

A shift in teaching must occur when implementing the Common Core State Standards for Mathematics (NCTM, 2014). As the SMPs are more practice-based instead of easily measurable through standardized tests, there is a chance teachers view the SMPs as ancillary materials instead of equal parts of the standards. This can lead to using them as simply another mandate to complete, without full implementation (Russell, 2012). However, taken as whole, the SMPs can be seen as related skills and ways of approaching mathematics instead of a list of eight separate standards that should be developed in students (Pilgrim, 2014).

Theoretical Framework

Figured worlds focuses on how people participate in socially and culturally constructed contexts (Holland, Lachiotte, Skinner, & Cain, 1998). This theory is largely based upon the work of Vygotsky and Bakhtin (Holland et al., 1998; Urrieta, 2007). Vygotsky emphasized individual development through social interactions. When applied to a learning situation, this leads to the zone of proximal development, an area one is cognitively ready to explore, but needs the help and social interaction of a more experienced other to support emerging understandings (Vygotsky, 1978). Symbols mediate the social interactions and impact self-formation. When interacting in a specific context (i.e., a third grade mathematics classroom), symbols help organize individuals' activities (Penuel & Wertsch, 1995). Using the symbols and artifacts to organize themselves allows individuals to impart meanings onto themselves and onto their interactions with others (Penuel & Wertsch, 1995).

Bakhtin (1981) contributed ideas related to authoring and dialogism. In short, Bakhtin (1981) argued the world must be answered. In this view, thoughts occur because of or in anticipation of social interaction. One can then produce meaning through dialogue (Holland et al., 1998). Dialogism also suggests people can hold contrasting thoughts at the same time (Bakhtin, 1981). Instead of one idea gaining an ongoing advantage, the dialogic process allows various ways of authoring to exist, with ideas gaining and losing advantage depending on the context. Thus, how one authors identity in a given context depends on the interactions with others in a given context (Holland et al., 1998).

Based on these theories, identities are produced over time, through interactions, and within a specific place (Holland et al., 1998). These specific places are called figured worlds. How individuals perceive the figured worlds can impact the figured worlds and the identities individuals create and recreate. Moreover, the ways individuals interact within the figured worlds are partly due to their experiences in other figured worlds, partly independent of these experiences, and due to outside forces (Holland et al., 1998). Thus, because each individual enters figured worlds with different experiences and experiences the figured worlds differently, identity development in figured worlds emphasizes the interactions within the figured world (Urrieta, 2007).

Three contexts are important for identify formation in figured worlds: positionality, spaces for authoring, and world making (Holland et al., 1998). Positionality focuses on issues of power, privilege, and how an individual views oneself in relation to belonging in the figured world. In a classroom, such positions could be good student, class clown, or talkative student, for example. Social categories (i.e., gender, class, and race) of individuals in figured worlds can create opportunities or barriers. Individuals must accept, reject, or negotiate the identities being offered to them in the figured world (Holland et al., 1998).

Space of authoring is based on Bakhtin's dialogism. The contrasting ideas individuals hold at the same time help shape their responses to the positions they are offered in a figured world. Holland et al. (1998) argued while novices in the figured world may accept the position offered by a more powerful figure, a more seasoned person might take the opportunity to shape worlds differently. How the individual decides to respond is a choice: accept, reject or negotiate; however, deciding not to respond is also considered a response (Urrieta, 2007).

Method

I used qualitative methods to answer the following research question: How do third grade African American students generate mathematics identities from their experiences in the figured world of the mathematics classroom? Specifically, I used a case study approach to explore the phenomenon of mathematics identities in the elementary classroom so that student voice is prioritized (Nieto, 1992) and to create a more complete picture of an individual's experiences (Berk, 2006). This paper presents the experiences of two female participants, Janae and Kayla, pseudonyms, in a third grade mathematics classroom in a large urban school in the United States.

The School & Classroom

The site of the research was Wildcat Academy, a pseudonym. Wildcat Academy was a large urban school in the Midwest United States serving nearly 900 students in grades prekindergarten through eighth. The school had persistently been labeled a failing school in terms of achievement performance by the state. Each grade level in kindergarten through sixth grade had three teachers, with four teachers per grade in seventh and eighth grades. Each classroom served 25 to 30 students, with the average being 28 students per classroom. In addition to the regular classroom, the school employed a cadre of resource teachers that ranged from music to physical education to creative writing. I served as a STEM resource teacher. Figure 4.14 displays the racial composition of the teachers and administrators at the time this study was conducted.

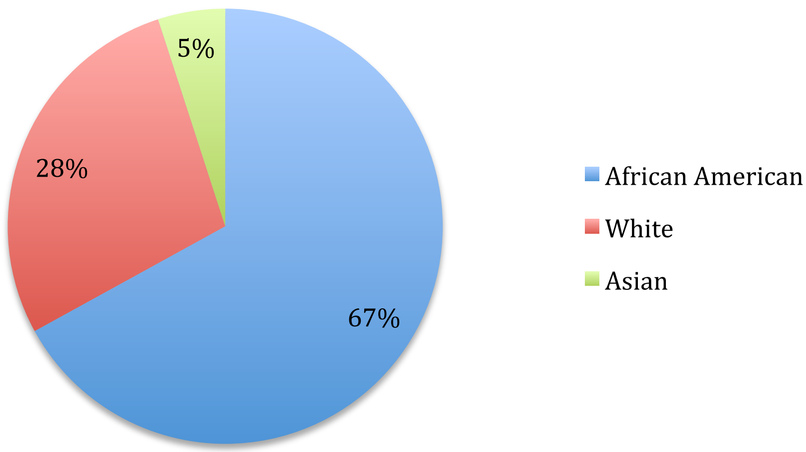


Figure 4.14. Racial composition of the teaching staff at Wildcat Academy.

The third grade teaching team consisted of three teachers. The administration organized the team to be departmentalized, a process in which each teacher specialized in one subject area. One teacher taught reading and writing. Another teacher taught science and social studies. The third team member, Ms. Madison, a pseudonym, taught mathematics. This study took place in Ms. Madison's classroom where she used the district mandated curriculum, *Engage NY*.

The students who attended Wildcat Academy were primarily neighborhood students. Only five buses served the school with many drops being within a three-mile radius. High levels of poverty and violent crime marked the neighborhood the school served. Accordingly, all students qualified for free and reduced lunch, a measure of poverty. Racially, the students were categorized[3] as predominantly African American with less than two percent of students being categorized as Asian, Hispanic, White, or

[3] I use the term "categorized" as I do not presume to know the race each student identified.

other. Figure 4.15 displays the racial composition of the students attending Wildcat Academy at the time this study was conducted.

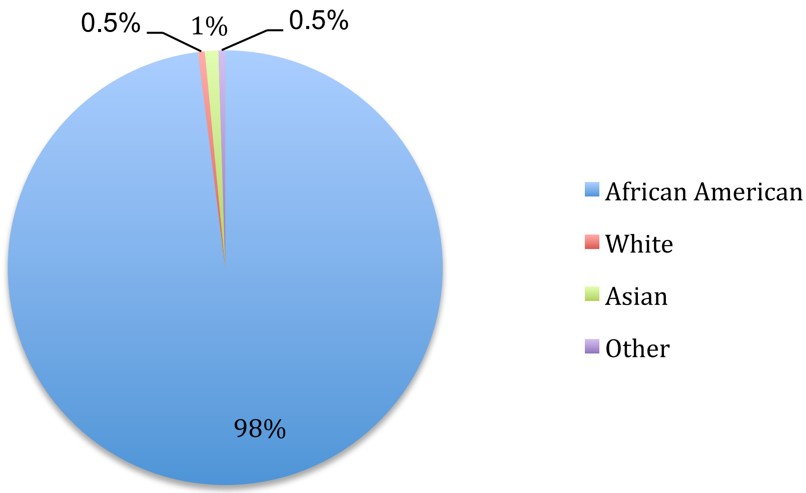


Figure 4.15. Racial composition of students at Wildcat Academy.

Participants

Purposive homogenous sampling was used to identify four African American third grade students, two boys and two girls, based on their grade level and status as an African American (Miles, Huberman, & Saldaña, 2014). Three students' guardians provided consent and the three students, two girls and one boy, assented to participate in the study. All of the student participants in this study were 9 years old at the time of the study, indicating none had been promoted early or retained in any grade.

Ms. Madison also gave consent to participate and was interviewed. Ms. Madison was in her fourth year teaching. At the time of conducting this study, she had taught in two states and focused on urban schools. She attended a traditional college of education, majoring in elementary education. However, she did struggle with obtaining her full teaching certification in the state where this study took place. Even so, Ms. Madison was recruited to Wildcat Academy due to her exceptional work in another school where her students posted the highest mathematics results in their charter network.

Data Collection

Data were generated using multiple strategies. First, the three student participants were given a brief qualitative questionnaire to gauge their attitudes about mathematics (See Appendix A). Second, stationary video and field notes were taken during all classroom observations. Third, each student wore glasses with an embedded camera during observations. The videos were used to help focus on what individual students attended to during the lesson while still gaining an understanding of what happened in the broader classroom around the student participants.

Finally, each student participant participated in three audio recorded semi-structured interviews, following the three-interview series model (Seidman, 2013). Interview protocols were designed to explore ways in which students learned about mathematics, related to mathematics, and conceptualized what was happening in the classroom. The second interview utilized stimulated recall as a way to have students explain what happened in the classroom while also privileging their voices. The classroom teacher also participated in an audio recorded interview to provide her clinical expertise regarding her students.

Data Analysis

Data analysis was an ongoing process throughout the study. Provisional codes were initially developed based on the extant literature (Miles, Huberman, & Saldaña, 2014). Interviews were transcribed after they were completed. Moreover, completed interviews informed the next round of interviews (Seidman, 2013). When analyzing the corpus of data I used open coding to develop another round of codes past the provisional codes (Corbin & Strauss, 1990). I then used the provisional codes and those established from open coding to establish more codes, which were used to code the transcripts.

Memoing was used as a reflective process and as an analytical process to determine the content of the second and third interviews. The memoing was based not only on the ongoing analysis, but also on the field notes from classroom observations. The videos provided yet another source of data to visually confirm codes or to contradict emerging understandings. These multiple sources of data helped triangulate the analysis. After the coding was complete, I looked for common themes and any divergent cases by looking at different categories for any patterns (Miles, Humberman, & Saldaña, 2014).

Findings

As I examined the data in light of the research question regarding how third grade African American students generate mathematics identities based on their experiences in the mathematics classroom, two primary themes emerged. The themes included the importance of using the SMPs to be successful in the mathematics classroom and the ability to use a growth mindset as a way to negotiate more positive positions and author more positive mathematics identities in the mathematics classroom. My findings were organized by each individual's experience before a comparison is made between the two.

Janae's experience

Janae's mathematics identity was founded on a core belief of persevering leading to success. "To be good in math," Janae explained, "I have to work hard." Her teacher, Ms. Madison, agreed with this belief. As Ms. Madison explained,

> A good student in math is a student who actually works diligently to solve problems. They persevere... It's not the one who always makes straight A's… But it's the student that tries their best.

Janae and Ms. Madison shared the belief in the importance of hard work. This alignment helped Janae maintain her positive mathematics identity through the positive positions Ms. Madison offers to her in the classroom. Janae was viewed as a hard worker, someone who Ms. Madison described as never giving up. Instead of giving up, Ms. Madison observed Janae "will look at [the problem] and try to find the third way or find a different way to solve this problem. Or she may call on her classmates to help her or me for a little bit of support." This effort was not only praised, but also allowed Ms. Madison to position Janae in two distinct ways.

First, she positioned Janae as a hard worker. This coincided with and reinforced Janae's beliefs about herself. There was no conflict here. Janae simply accepted the position and used it to author a continued positive mathematics identity. Relatedly, Ms. Madison and Kayla shared the perspective that success in mathematics is achieved by hard work. Therefore, those who work hard in mathematics are good mathematics students. This positioned Janae as a good mathematics student in the eyes of Ms. Madison. Again, there was no conflict in the position here. Janae accepted the position and used it to reinforce her positive mathematics identity within the classroom. While these shared values provided a relatively easy way for Janae to author a positive mathematics identity in Ms. Madison's classroom, how Ms. Madison structured the class also positioned Janae in varied ways. Specifically, Ms. Madison's instructional style and her focus on the SMPs influenced Janae's positions and mathematics identity.

Ms. Madison described her instruction as “very hands on” and emphasized her “modeling with mathematics, and modeling with tools.” When I asked her for more specifics, Ms. Madison explained her general process for instruction:

> So first I would give [the students] an overview of the learning target… We talk about all [relevant ideas] in order for me to jog your memory based on previous lessons. If it were introducing a lesson I would give them these vocabulary terms… After the introduction, the opener, then what we’ll do is we’ll actually dig into the actual guided practice where I’m doing something for them and I’m thinking through it out loud. Once I think through it out loud, I provide another example, We think through it together. Another example, we think through it together before I actually release them to work on their own or to work with a partner…[If students do not understand, we] walk back through this same thing and let’s do it a different way.

Her explanation matched my observations in the classroom. For example, when working on the 9s in multiplication facts, Ms. Madison reviewed skip counting and also gave students a shortcut with using their fingers to determine the solution. She reinforced the connection by having students skip count and use their fingers, as seen in Figure 4.16.

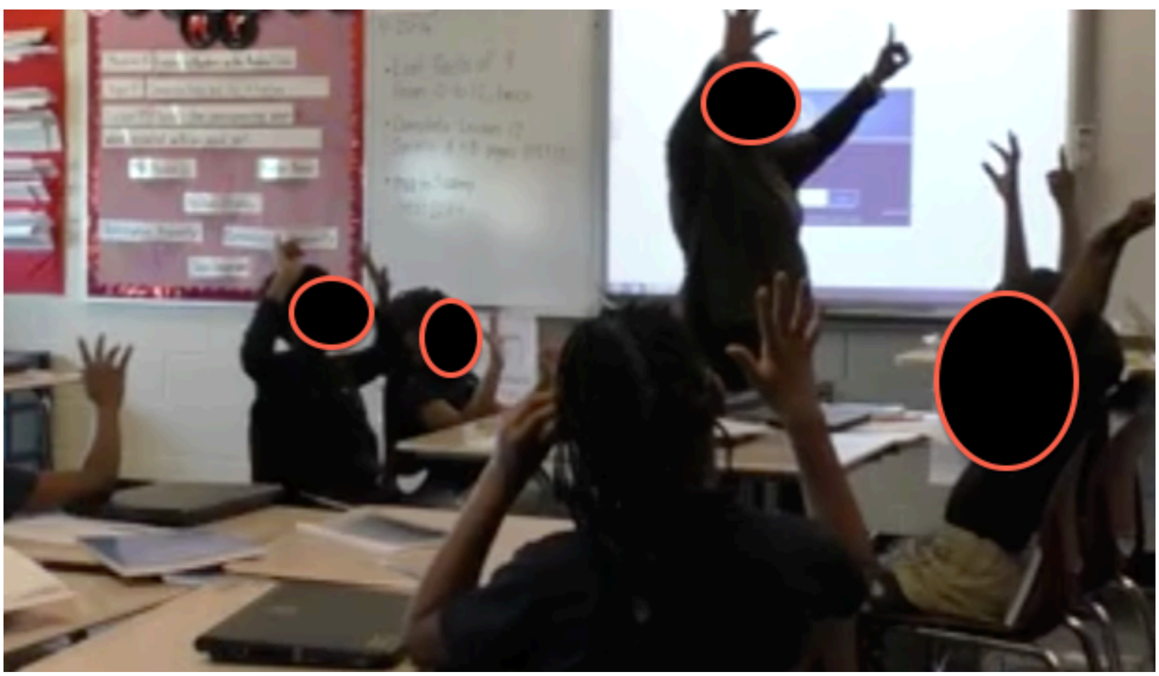


Figure 4.16. Ms. Madison skip counted. Ms. Madison modeled another strategy for multiplication.

Janae thrived in this type of instruction. She appreciated the explanations from Ms. Madison. As Janae said, “Ms. Madison helps me understand by explaining [the content]… She draws pictures… She gives us examples of how to do the steps, too.” These multiple strategies generated by and shared by Ms. Madison were positive experiences for Janae. So, too, were the working conditions.

Ms. Madison did not use a lot of group work in her mathematics classroom. As she commented,

> I guess I can just speak for my classroom having so many different diverse backgrounds and so many kids from different areas [of the neighborhood], some [students] are relatives. Some are not. I feel like…when we are talking about group work, you know you can’t seem to get along with other people who are not from where you’re from because they may be different from you.

The different neighborhoods within the school community posed a problem initially for doing group work. Due in part to this limitation, Ms. Madison did not implement a lot of group work in her classroom. Instead, partner work and individual work were key practices.

Janae preferred these practices. When asked about her least favorite activity in mathematics class, Janae quickly identified group work. “I just like to work alone,” she demurred. When I probed further she admitted that during group work, the groups tend to go off topic, which leads to distractions. However, Janae did not hesitate to ask someone for help when she needs it. She only pursued help after she had attempted to solve the problem multiple ways on her own, though. For example, in Figure 4.17, Janae missed the problem about identifying shapes that can be classified as rectangles twice. After her second mistake, she asked the student beside her for help. Ms. Madison’s instructional style and Janae’s preferences for working alone and attempting to solve problems on her own matched well. Because Janae excelled in this type of environment, her actions were part of the norms. She was positioned as a normal and valuable part of the classroom. She did not have to negotiate this position as it matched her own beliefs and mathematics identity.

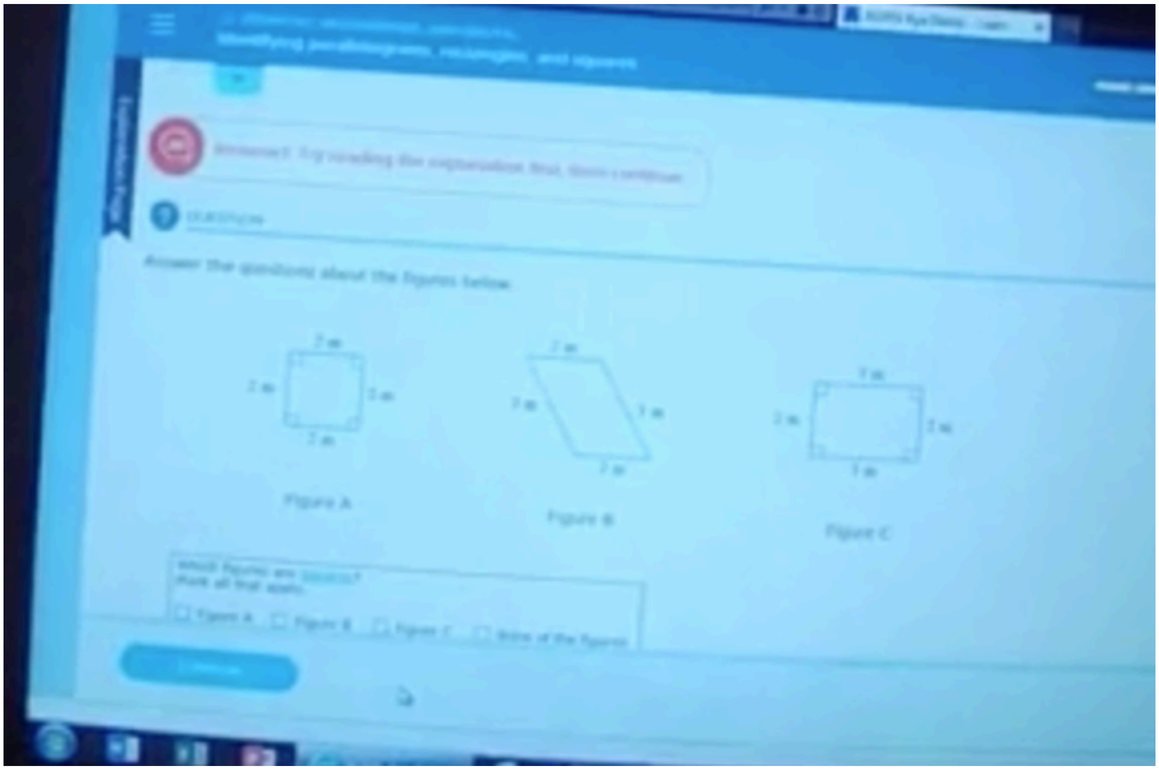


Figure 4.17. Janae got the wrong answer. Janae answered the question wrong and was prompted to read the explanation before trying again.

Janae also favored Ms. Madison's emphasis on the SMPs during her instruction. For example, during a lesson on area, Ms. Madison facilitates a discussion that highlights students' constructing viable arguments and critiquing the reasoning of others. Based on the model as seen from Janae's perspective in Figure 4.18, Ms. Madison instructed students to discuss the following question with their partners: "Was it necessary to actually fill in the missing pieces in order to find the area?" After their discussion, Ms. Madison called on one partner to share their response and their reasoning. Once that student shared their response, Ms. Madison went to another student to ask them if they agree or disagree and why. When one student explained that they did not think the missing pieces needed to be filled in, Ms. Madison probed further:

> So how could you determine the area without filling in the blanks? Without using the ruler, attending to the precision, and using appropriate tools. Without doing all of those mathematical practices that we know, how could… you determine the area using what they have already given you?

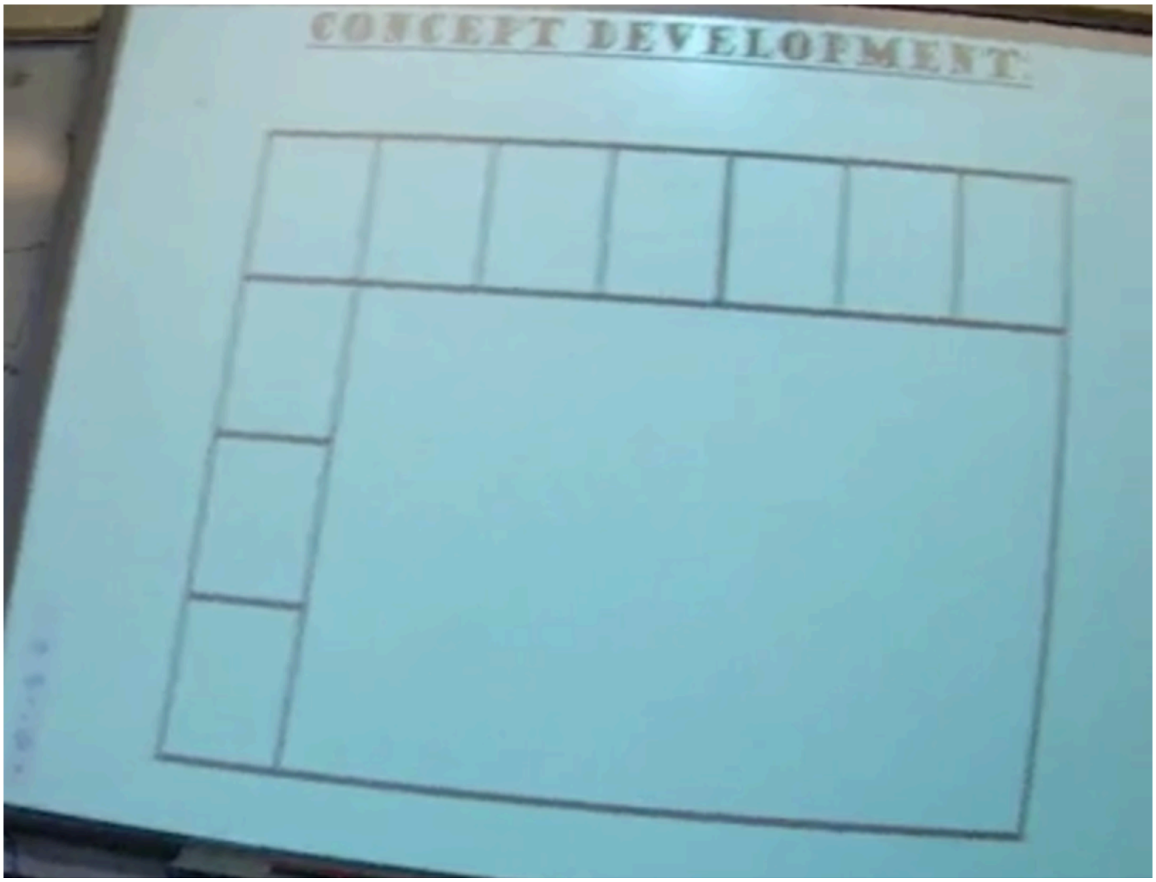
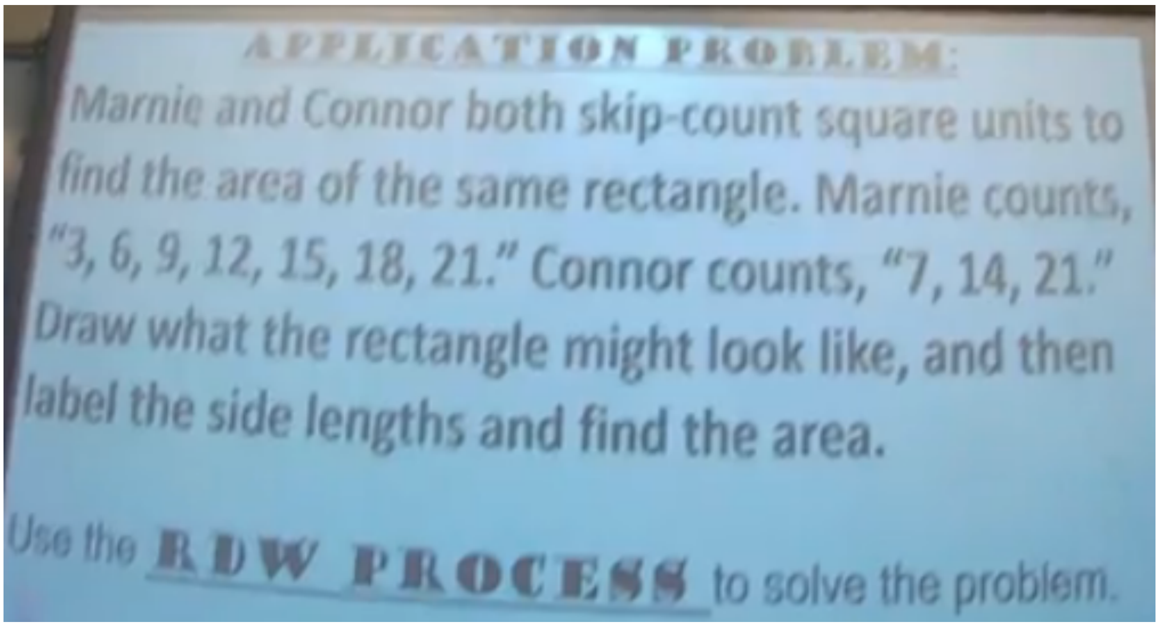


Figure 4.18. Ms. Madison's area task. Students were instructed to determine if the other blocks were required to calculate area.

In this particular example, Ms. Madison makes explicit reference to two other practices while facilitating students' construction of viable arguments and critique of others' reasoning. Throughout the discussion, student responses indicated they could see another way to solve the problem that was more efficient. Using a ruler to draw the pieces and attending to precision while drawing would take longer than recognizing the structure, another SMP. By recognizing the structure, students understood they could use a simple multiplication fact to solve the problem.

Janae internalized Ms. Madison's explicit focus on the SMPs. Her use of the SMPs was clear in a variety of situations. For example, Janae worked diligently to attend to precision to complete the problem as seen from her perspective in Figure 4.19.



4.19. Area application problem. Ms. Madison assigned a problem that required students to draw area models to meet specific criteria.

To begin solving the problem, Janae attended to precision in creating her model as shown in Figure 4.20. She used a ruler to measure each side and to ensure each part was separated into equal pieces. She ultimately drew a three-by-seven rectangle and a seven-by-three rectangle as a way to check her work. Both examples show how Janae attended to precision without prompting from Ms. Madison; instead, she had internalized the importance at this point and took care to make precise representations. Thus, using the practices helped Janae be successful in mathematics and she realized it.

Figure 4.20. Janae attended to precision while answering an area task. Janae worked on the task seen in Figure 4.19.

Janae also regularly exhibited the first SMP, make sense of problems and persevere in solving them. For example, Figure 4.21 shows a geometry problem. The task asked students to prove a rhombus could also be a rectangle. Janae struggled with the problem. She was ultimately unable to answer the question; however, she persevered by trying to use multiple strategies. For example, she attempted to make shapes by placing lines on the coordinate plane as seen in Figure 4.22. She also tried to plot points to answer the question as seen in Figure 4.22. While she was unsuccessful in the end, she persisted. She tried a variety of strategies to answer the question.

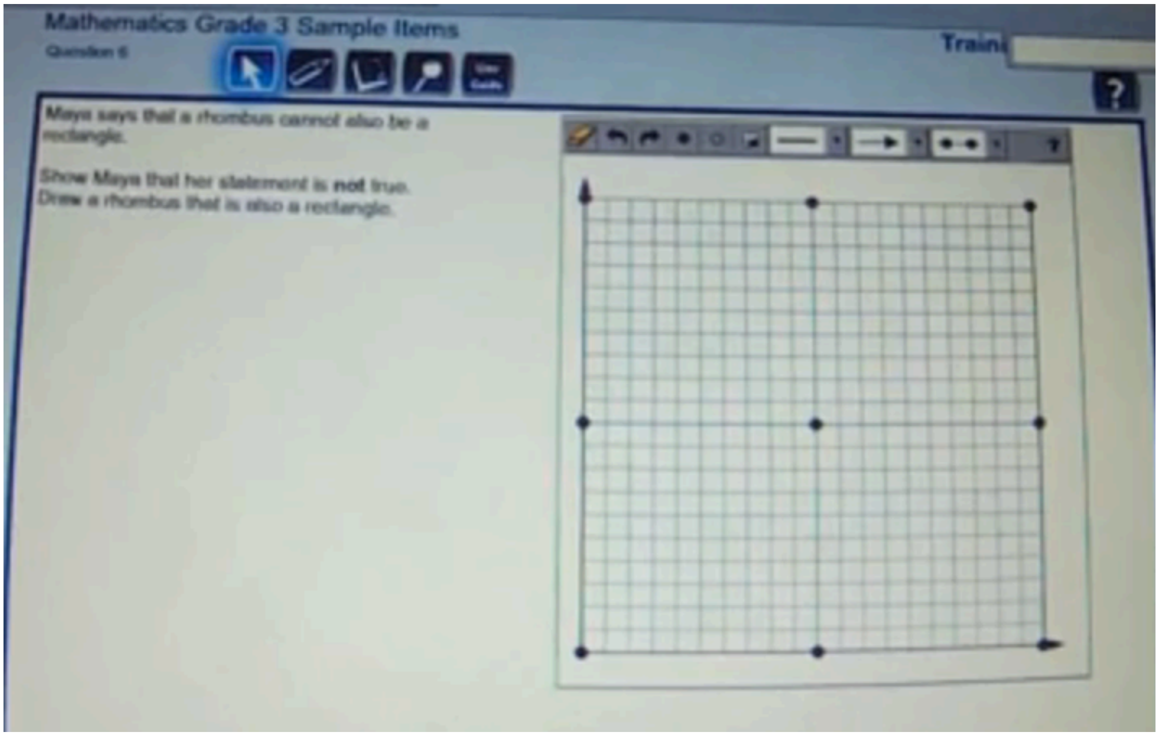


Figure 4.21. Rhombus and rectangle task. Janae confronted a task that asked her to prove a rhombus can be a rectangle.

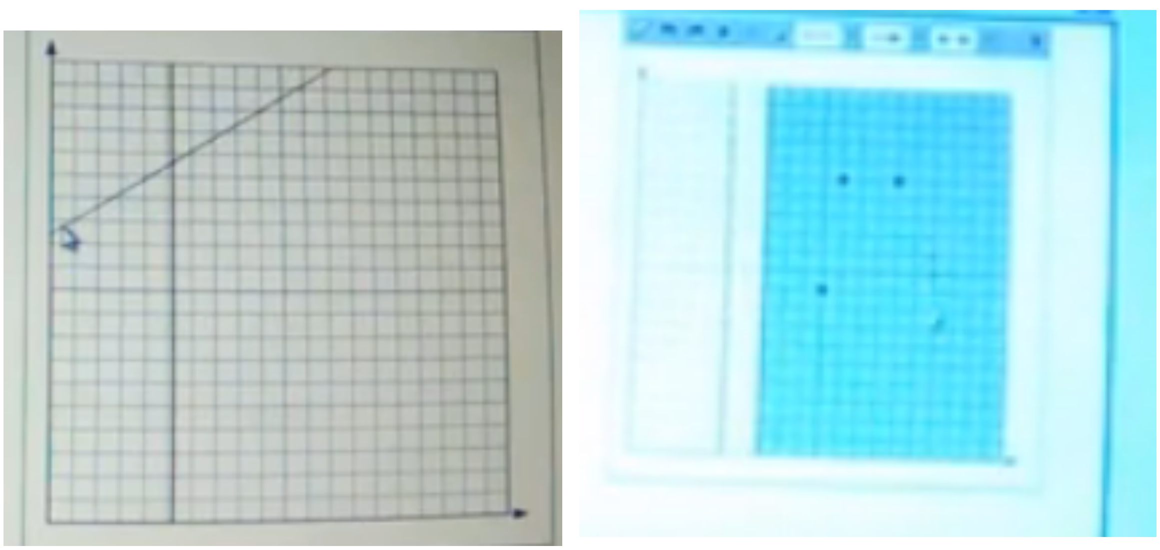


Figure 4.22. Janae tried multiple strategies. On the left, Janae tried using lines to answer the question. On the right, Janae tried plotting points to answer the question.

This focus on perseverance and hard work also helps Janae maintain her growth mindset. In one of our conversations, Janae told me, “if you practice and try and work hard anybody can be successful" in mathematics. She held herself to that in countless examples. Throughout her experience in Ms. Madison's mathematics class, Janae consistently worked hard. She fit in with the norms of the classroom where hard work, completing work on your own, and utilizing the SMPs were valued. As such, the positions she was offered were mostly positive. Ms. Madison's view of her and interactions with her positioned her positively. As Ms. Madison said of Janae, "I believe Janae is a good math student because Janae never gives up. Even though there are times where she gets frustrated… she never gives up. So as far as her being a good math student, definitely."

Kayla's experience

Kayla's mathematics identity was also rooted in her belief in hard work; however, she equally emphasized the importance of focus to succeeding in the mathematics classroom. Kayla was never able to explain what she meant by focusing in the mathematics classroom. Moreover, my observations and her videos showed her less likely to focus in the classroom. For example, in one class period Kayla is easily distracted by a variety of actions. While Ms. Madison explained how to find the area of an irregular shape (See Figure 4.23) and emphasized the importance of attending to precision, Kayla was distracted at least four times in the first nine minutes of class. Three of those times she left her seat to get tissue, which she promptly threw away. Another time she took part in a conversation unrelated to the task at hand. As Ms. Madison moved to a new example on the board after nearly ten and one-half minutes, Kayla realized she had not yet solved the problem and groaned, "Nooo" to herself.

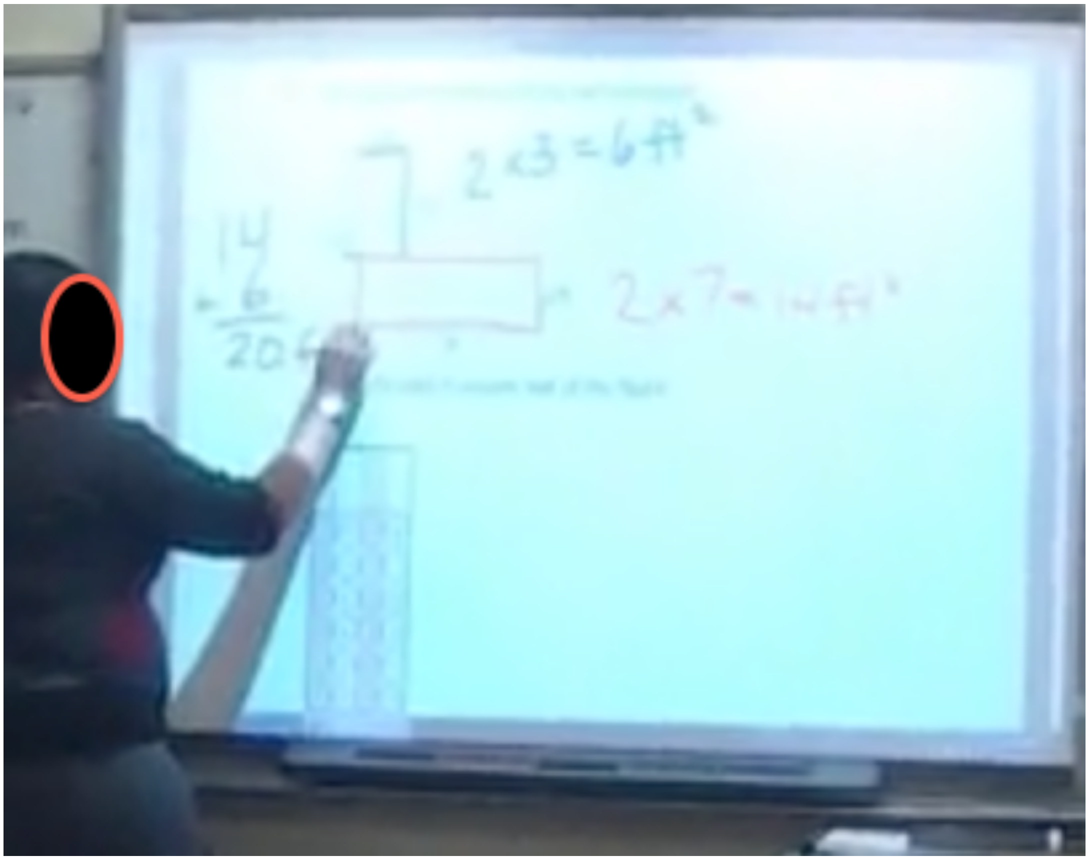


Figure 4.23. Ms. Madison solved area of an irregular shape. Ms. Madison showed students how to find the area of an irregular shape.

While her lack of focus was evident, Kayla was working to attend to precision in her notebook, just as Ms. Madison had asked. Figure 4.24 shows Kayla working on carefully labeling and drawing the figure in her notebook. The time Kayla spent working on drawing and labeling the figure reflects her limited understanding of the SMP, attend to precision. During one of our conversations, I asked Kayla about attending to precision.

I: [Ms. Madison] does talk about [the SMPs]?

K: Mhmm.

I: How does she talk about them?

K: She tell us which standard we are working on.

I: Ok so what are some examples?

K: I don't remember.

I:Hmm. I think attend to precision is one of them[4]… When would she talk about that?

K: When we do number lines.

I: Oh why would she do that then?

K: So our work can look neat.

I: So you think just the work looking neat is attending to precision?

K: Mhmm.

I: Ok. Is there any math reason why that may be important with number lines?

K: No.

In my initial reflection on this conversation, I thought Kayla's misunderstanding of how attending to precision when partitioning fractions on a number line could be due to potential misconceptions related to fractions. However, her inability to apply the practice in area made me think she missed the true point of attending to precision. For Kayla, attending to precision was about producing neat work. Therefore, she took her time drawing. She made sure to label appropriately. She did not use the practice enhance her understanding of content. Success, whether in recognizing her own understanding or in meeting the teacher's expectations, was one way students positioned themselves positively in the class. In this instance, Kayla was attempting to meet Ms. Madison's expectations of using the SMP of attending to precision appropriately. She did not do so and realized she was not meeting the expectations. Thus, she was positioned outside of

[4] I interviewed Kayla last. Based on this, I knew the student participants had just focused on attending to precision in a recent task. Therefore, in an attempt to probe her understanding, I asked specifically about it.

the values of Ms. Madison's mathematics classroom. This did not reinforce her mathematics identity as a good mathematics student. She had received good grades in the past and continued to receive good grades in Ms. Madison's class. Thus, she was receiving external validation of her status as a good mathematics student. This example from class, however, showed that her journey was not always positive. Instead, she often struggled to meet the expectations in Ms. Madison's class. This failure positioned her outside of the realm of successful mathematics student, which forced her to find ways to negotiate her desired positive mathematics identity and the often less positive positions she was offered.

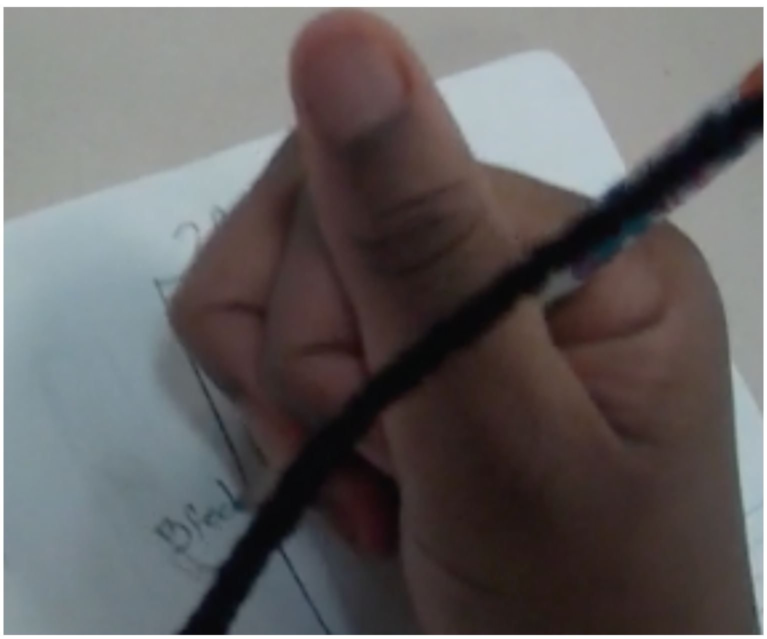


Figure 4.24. Kayla attended to precision. Kayla drew a precise model when working on a task.

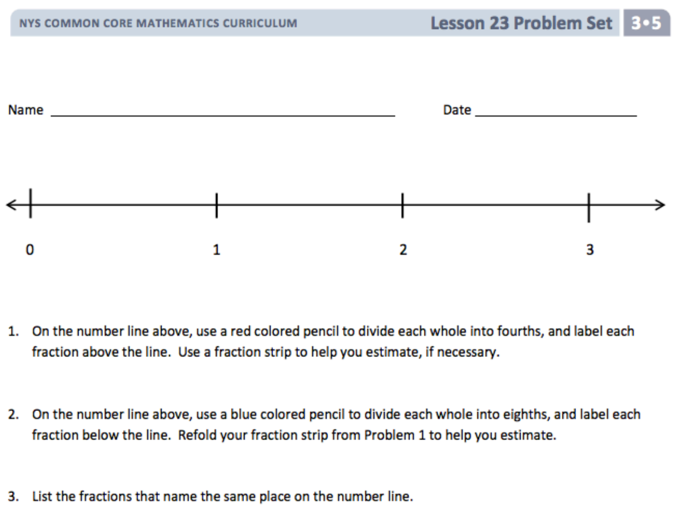
From my conversations and observations, two different issues related to Kayla's struggles. First, while Kayla talked about the importance of focus, she often did not exhibit it in class. The previous discussion highlights a typical example. Second, Kayla was positioned in opposition to the norms of the classroom throughout the class. While her varying states of focus contributed to this, Ms. Madison and her instructional practices also offered her difficult positions.

Ms. Madison was clear when she defined a good mathematics student. "A good student in math is a student who actually works diligently to solve problems. They persevere." Kayla's lack of focus made it appear that she was not always working diligently. Kayla, according to Ms. Madison, was not a good mathematics student.

> I would not describe Kayla as a good math student…simply because Kayla does not put forth the effort that she needs to. She gets easily frustrated, easily distracted, and will give up… Kayla will sit and wait on someone to give her answers… She's still rushing through her work.

Ms. Madison's statements reflect a clash of values. Although Kayla said hard work and focus were important factors to succeeding in mathematics, she demonstrates a lack of focus. The lack of focus also showed up as a lack of effort. Thus, while they claimed to have similar beliefs, Kayla did not demonstrate those beliefs in Ms. Madison's classroom. As a result, Ms. Madison often positioned her as a lazy student.

For example, in the fraction number line problem seen in Figure 4.25, Kayla gave up fairly quickly. Figure 4.26 shows when Janae captured this moment as she looked at her group when she finished one part of her problem; Kayla had her head down and appeared to have given up. Soon thereafter, Ms. Madison came by the table and told Kayla to "stop spacing out." After this comment, she helped Kayla get started on her work again; however, Ms. Madison had already verbally positioned Kayla as unfocused. Unfocused and not working were not positive characteristics in the norms of Ms. Madison's classroom. Thus, Kayla was offered a position contrary to her identity as a good mathematics student.



NYS COMMON CORE MATHEMATICS CURRICULUM Lesson 23 Problem Set 3•5

Name ______________________ Date ____________

0 1 2 3

1. On the number line above, use a red colored pencil to divide each whole into fourths, and label each fraction above the line. Use a fraction strip to help you estimate, if necessary.

2. On the number line above, use a blue colored pencil to divide each whole into eighths, and label each fraction below the line. Refold your fraction strip from Problem 1 to help you estimate.

3. List the fractions that name the same place on the number line.

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Figure 4.25. Fraction Number Line Task. This task required students to partition a number line and then iterate the individual pieces.

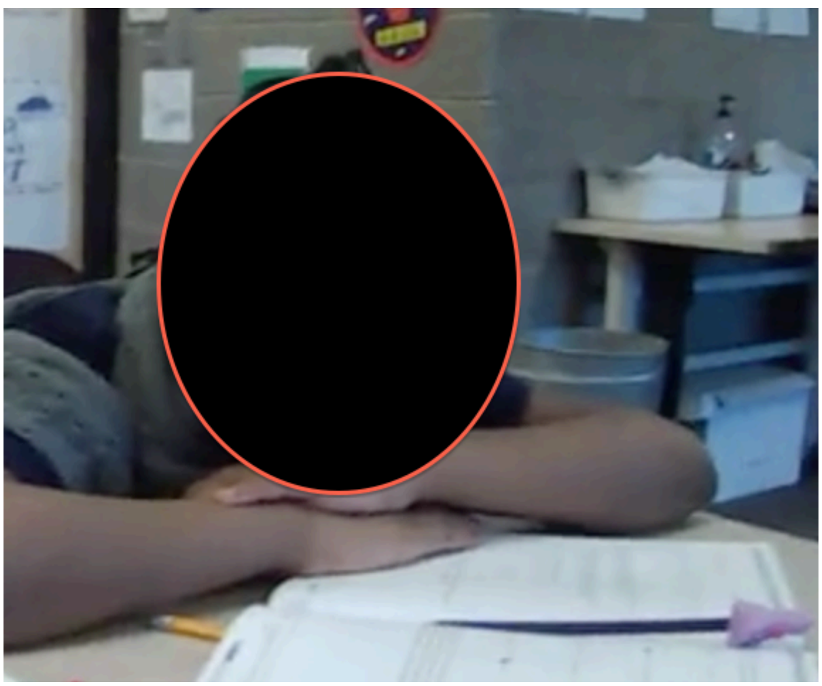

Figure 4.26. Kayla gave up. Janae captured this image of Kayla during their work time on a fraction problem.

Kayla reacted in a way that attempted to show compliance. She began working and trying to solve the problem. Compliance, in this particular case, is a difficult concept.

It was not just Ms. Madison as an authority figure imposing her beliefs, but Kayla enacting what she identified as important to succeeding in mathematics. She began applying the ideas behind the growth mindset she espoused. Kayla's problem, though, was her inability to consistently apply a strong work ethic.

This is not an isolated case of Kayla quickly giving up or not focusing on her work. In the rhombus and rectangle problem (Figure 4.21) discussed in Janae's experiences above, Kayla also struggled. However, she did not persevere. She chose to find other ways to use her time. This included multiple trips to get a tissue and distracting those around her as seen from Janae's perspective in Figure 4.27. While this is not unusual behavior in a third grade classroom, Kayla's reaction typified her actions in the classroom. Even though she consistently talked about the importance of hard work, she rarely showed an interest in persisting through tough problems in the classroom.

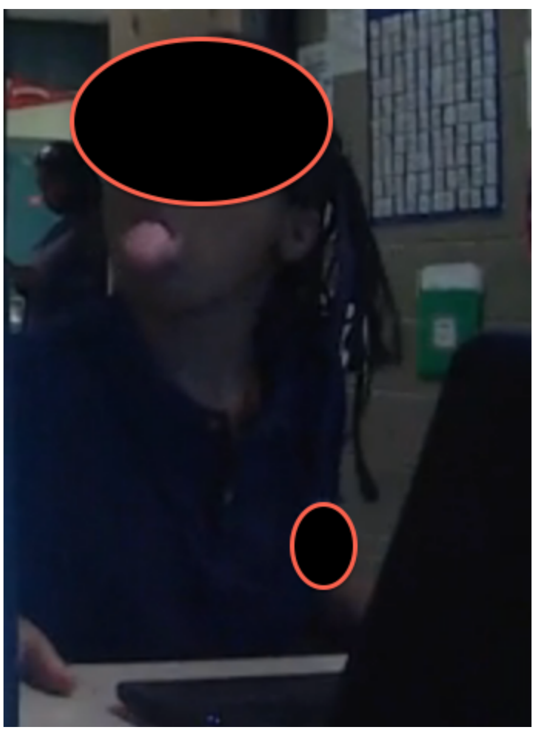

Figure 4.27. Kayla became distracted. Kayla stuck her tongue out at Janae while she was avoiding her work.

Ms. Madison's instructional practices did not help Kayla consistently work hard. In our conversations, Kayla repeatedly identified group work as an important way she learned.

I: What activities help you learn math?

K: Group work.

I: Do you all do a lot of group work?

K: Sometimes…

I: How does group work help you?

K: Because I help other students and other students help me.

Ms. Madison, though, did not favor group work in her classroom. Instead, she explained her process as introducing a topic, modeling for students, providing other strategies when needed, and then releasing students to work individually or with a partner. Once again, there is a clash in the positions offered to Kayla. Kayla likes the peer interactions in learning mathematics. Ms. Madison does not offer that regularly. Thus, Kayla's preference for group work positions her outside the norms of the classroom. She negotiates this position in a variety of ways. Sometimes she gives up, as if she accepts her lesser position. Less often, Kayla uses the negative position offered as motivation to push through her work. Ms. Madison described this as rushing through her work. However, Ms. Madison also noted Kayla generally receives B's or A's in the class. Thus, the rushing does not seem to impact her overall grade. Instead, it impacts the way in which she works in the mathematics class.

Kayla maintained her positive mathematics identity primarily through her belief in her ability to work hard to achieve. Throughout the class, Ms. Madison was both encouraging and discouraging to Kayla. Ms. Madison made an effort to positively reinforce the class and emphasize the importance of trying. For example, when students were struggling with early fraction concepts, Ms. Madison announced, "guys don't get frustrated. I know this is new. Keep trying. We will get there." She did not emphasize the correct answer. She emphasized perseverance. Kayla responded to this message. She consistently claimed to believe in the importance of hard work and focus. She just did not consistently act on that belief in the classroom.

Ms. Madison recognized the disconnect Kayla faced. In predicting how Kayla would describe herself as a mathematics student, Ms. Madison commented,

> I think she would say she is a good math student… because she has a pretty good grade. So I think she would look at just overall grading. Why I have a B. I have an A. I'm a good math student. But [she would not really know] the components of a good math student.

Overall grading, though, was inconsistent. All three students talked about not receiving feedbacks on assessments. Thus, the position offered to Kayla by her grades was inconsistent. Her grades measured her ability to get correct answers; however, Ms. Madison's explanation of a good mathematics student focused on process, not correctness. Consequently, Kayla continued to cling to the idea that she worked hard for her grades which reflected her mathematics identity as a good mathematics student. However, her grades did not measure the processes valued by Ms. Madison. Thus, Kayla's experiences in the classroom were much more difficult as she negotiated a range of positions against her identity as a good mathematics student.

Comparing Janae and Kayla's experiences

Kayla and Janae experienced Ms. Madison's class very differently. Ms. Madison valued the process of working hard to understand mathematics. Kayla and Janae both claimed to value the same thing. However, Kayla's actions differed from Janae's actions. Kayla did not always persevere in problems, especially without regular praise. Janae consistently worked hard to solve problems. Thus, Kayla had a bigger challenge in that her teacher's description of her and expectations of her in the classroom did not position her for the most positive interactions with mathematics.

This leads to two divergent issues at work: positioning by the teacher and positioning by the pedagogy. Both students exhibited a growth mindset in mathematics in both word and action. The issue was Kayla was not consistent in enacting her stated beliefs. Kayla's motivation required a more internal drive, especially when she was not receiving regular praise. She received good grades to validate her identity as a good mathematics student, but she knew she had to work to understand the content as the teacher did not offer positive positions in the classroom. This is not to say Ms. Madison intentionally excluded her. There are several instances of Ms. Madison working with Kayla to help her understand the content; however, Kayla's actions did not always reflect the prioritized values in Ms. Madison's classroom.

While Janae also communicated the importance of hard work, external validation was in ready supply for her through positive interactions with her teacher. Janae consistently persevered in solving problems. Grades served as another validator of Janae's positive mathematics identity, but did not weigh as heavily in her mind as they did for Kayla. Thus, Kayla's position in the classroom was consistently being negotiated and renegotiated while Janae simply accepted her position within the figured world of the mathematics classroom.

Ms. Madison's pedagogy also positioned the students differently. The classroom was traditional in that students took notes on the teacher's explanations, practiced problems, and mainly completed tasks individually. Janae thrived in this situation. She liked working by herself and did not want to be distracted by her peers in group work. Kayla did not prefer this environment and repeatedly mentioned her preference for group work because she could work with others. For Kayla, working with others was a way to help others and to have others help her learn the content. In fact, when she worked alone she was often distracted. Thus, Kayla again had to negotiate her position in the classroom to maintain a positive mathematics identity while Janae was able to accept her position as a good mathematics student. Kayla's negotiation occurred when the position offered to her differed with the position she desired and claimed. Janae did not negotiate not because her experiences were predominantly positive, but because the positions offered to her by Ms. Madison aligned with those she desired and claimed for herself.

This constant tension also showed up in how Janae and Kayla were able to talk about and use the SMPs. The first SMP is to make sense of problems and persevere in solving them. Janae consistently demonstrated this SMP in her actions while Kayla rarely took the time to make sense of problems. Moreover, without praise, she often lost the desire to persevere to solve the problem. The primary exception to this was when Kayla persevered through an assignment so her grade would continue to reflect her identity as a good mathematics student.

Attending to precision provided another example of how Janae and Kayla differed in their understanding and application of the SMPs. Janae understood attending to precision was an important process because it helped her understand the content, such as equidistant marks on a number line representing equal parts of a fraction. Kayla, on the other hand, understood attending to precision as an aesthetic practice. When she attended to precision, her goal was to have neat work. Unfortunately, this misapplication of the SMP led her to consistently playing catch up or getting frustrated when the class moved on, as shown in Figure 4.24.

Discussion and Conclusion

Kayla and Janae's experiences offer different perspectives in the same mathematics classroom. Both students recognized the importance of the Standards for Mathematical Practice as ways of doing mathematics. For example, Janae and Kayla both emphasized the importance of hard work and trying in order to be successful in mathematics. That is a major component of making sense of problems and preserving in solving them; however, only Janae consistently enacted her belief. Both students attempted to apply the SMPs in their work. However, Janae understood how the SMPs helped her with the content; Kayla did not make the connection.

Janae and Kayla also both possessed a growth mindset in mathematics. They repeatedly mentioned hard work and effort as keys to success in mathematics across our multiple conversations. However, the application of their growth mindsets occurred in different ways due to the positions they were offered in the mathematics classroom as Janae received more favored positions than Kayla did. Janae was able to accept the positions she received in the classroom with limited negotiation. The positions she was offered matched the positions she desired and already held. Kayla, on the other hand, had to work harder for validation as a good mathematics student. She did not persevere daily without regular praise from Ms. Madison. Thus, she was often positioned in ways that challenged her identity as a good mathematics student. Kayla did work hard for her grades, and her high grades reinforced her identity as a good mathematics student. But on a daily basis, Kayla was not positioned as a good mathematics student because her actions did not conform to the privileged actions set by the norms in the figured world of Ms. Madison's classroom.

Pringle, West-Olatunii, Brkich, Archer-Banks, and Adams (2012) suggested stereotypical views of gender-based subject strengths (i.e., girls are more interested in reading and writing) and limiting pedagogy due to classroom discipline issues negatively position African American girls' positions in the classroom. These issues were not evident in Ms. Madison's classroom. Janae was positioned positively throughout her experiences. Kayla's negative positioning was due more to her desire to experience different strategies to support her learning.

Pedagogy also matters in the development of both students' mathematical identities (Boaler & Greeno, 2000). The instructional decisions by the teacher favored Janae more than Kayla. Although Kayla never described the activities as detrimental to her learning, she repeatedly wished for more group work because she learned better when interacting with her peers. In the more traditional classroom, Kayla's peers were a distraction because their conversation happened in isolation and outside of classroom norms. Janae on the other hand was easily distracted by her peers during group work and preferred working alone. This again created a more positive position for Janae than for Kayla within the classroom. The pedagogy decisions made by the teacher can privilege some students more than others, potentially creating disparate opportunities for some students to develop positive mathematics identities. This supports the findings of

Baratelli, West-Olatunji, Pringle, Adams, & Shure (2007) who emphasized how pedagogy positions students as members of the science and mathematics communities or as outsiders.

One implication of this study is the importance of studying mathematics identity in younger students. Several studies focus on adolescents' mathematics identities (e.g., Berry, 2008; Boaler & Greeno, 2000). The elementary age group is virtually ignored. Janae and Kayla both demonstrated positive mathematics identities. However, their formation and preservation were vastly different. More research is needed to show how to support positive mathematics identity development as students transition into more advanced mathematics. Furthermore, future studies should also focus on specific classroom practices that support all students' positive mathematics identity development.

Chapter 5
Implications and Significance

While more studies are being conducted regarding successful African American students in mathematics, the dominant discourses of rejection and deficiency (Stinson, 2006) remain. With the continuation of standardized testing and researchers enthralled with a “gap-gazing fetish” (Gutierrez, 2008), the possibility of focusing solely on the gaps and perpetuating the dominant discourses remains. While many mathematics education researchers continue this focus, in this study I chose to focus on successful African American elementary students by qualitatively investigating their experiences in the mathematics classroom. I found an explicit instructional focus on the Standards for Mathematical Practice to be critical for not only student understanding, but also for development of positive mathematics identities. In short, as students internalized the SMPs, they associated those practices with being good at doing mathematics. Moreover, the ways students were positioned in this classroom had an impact on their mathematics identity. Janae was consistently positioned positively and had little struggle in retaining a positive mathematics identity. Kayla, on the other hand, was not positioned as positively. She had to rely more on her own perseverance and growth mindset to maintain her positive identity. In the remainder of this chapter, I discuss implications, limitations, and significance of this study.

Implications

Implications for the Classroom

With the acknowledged hesitation of shifting focus away from students and onto teaching practices, this study does suggest several classroom practices that can benefit African American students’ mathematics identities. First is an explicit focus on the

Standards for Mathematical Practice. Ms. Madison's repeated explanation and emphasis on attending to precision when using a number line for fractions not only strengthened student understanding, but also their mathematics identities. Janae internalized this practice as critical when drawing fractions on a number line because her visual represented equal parts of a whole. By implementing this practice, she was not only meeting her teacher's expectations, but Janae was also identifying as someone who is good at mathematics.

Important here is the idea of explicitly focusing on the SMPs. Ms. Madison modeled and explained the SMPs each time she used them. They were not something to post on her wall or include in her lesson plan. The SMPs were explicitly taught and modeled, just as the content was. Thus, an explicit focus on the SMPs should include explaining the SMPs, using them in examples and classroom discourse, and modeling how to use them so that students are able to understand these important processes.

Second, students who possess a growth mindset are more likely to generate positive mathematics identities. Janae and Kayla both expressed that, albeit in different forms. Janae was able to persevere through problems and get support when she needed it. This reinforced her idea of achieving as long as she kept trying. Kayla had no other choice but to persevere for success. She received less favorable positioning within the mathematics classroom and had to spend a significant amount of time working to understand the content. Both students, though, retained their fundamental belief that hard work can lead to understanding, the essence of a growth mindset. Classroom teachers should work hard to instill this value in students. Being explicit with the SMPs complements this strategy. The first SMP, make sense of problems and persevere in solving them, focuses on the importance of perseverance. As teachers teach and model this skill in the classroom, it reinforces the growth mindset idea of hard work leading to success. Moreover, possessing a growth mindset is part of having a productive disposition, "the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, *to believe that steady effort in learning mathematics pays off*, and to see oneself as an effective learner and doer of mathematics" (NRC, 2001, p. 131, emphasis added). Without a growth mindset, students, especially those who struggle or who, like Kayla, are in a classroom that does not present instruction in a way they prefer to learn, it is difficult to find the value in mathematics and to generate positive mathematics identities.

Finally, how teachers position their students in mathematics classrooms matters. Students who are positioned as capable learners and doers of mathematics generate positive identities with less resistance than those who are positioned as students who struggle or who are in need of constant correction. Teachers communicate the positions they offer to students in a variety of ways. For example, the tasks teachers choose to present to students sends an important message about what is expected from students. Is it a low-level worksheet where students are merely expected to use a standard algorithm twenty times? Or, is it a task that encourages students to take what they know about fractions and solve it through a variety of representations? The first task positions students as robotic copiers. Thinking is not needed. Just a simply ability to copy the use of a specific rule or procedure. The latter task positions students as problem solvers who must make sense of the problem and use multiple representations to apply their content knowledge.

Important in this positioning discussion is the role of technology. Janae and Kayla had different perspectives on using computers. While it was designed to be adaptive to their learning needs, the presentation lacked the relevance of their teacher-led lessons. Thus, in the lessons in which they were using computers, the students were positioned differently. Kayla's effort and focus were missing. Janae described enjoying the work because it was "a challenge." The important point in this example is not that technology should never be used; instead, technology should be used to enhance a lesson, just as the problems teachers choose should enhance a lesson. Technology use for the sake of technology can be as disengaging and position students as poorly as a low-level worksheet can.

Implications for Future Research

In Lubienski and Bowen's (2000) review of mathematics education articles published between 1982 and 1998, only five percent focused on race, ethnicity, and socioeconomic issues. Furthermore, Gutierrez (2008) found a similar result for the next decade of articles:

> A review of *JRME* articles from 1999 through 2008 reveals a similar trend. Ignoring book reviews, 17 research articles out of 124 address issues of race, class, gender, language, or equity broadly related. Of those articles, only five frame these issues in political terms, as related to racism, classism, language politics, or gendered lives. (p. 58)

Thus, while Jackson and Wilson's (2012) review noted the increase in studies focusing on African Americans in mathematics, the topic remains marginalized in the mainstream body of research. More studies like this are needed to fully understand African American students' experiences in the mathematics classroom and to better understand the experiences of successful African American students in mathematics.

Relatedly, based on the findings of this study, more research is needed to examine the development of African American students' mathematics identities. If Janae and Kayla maintained a positive mathematics identity through a significant change year, third grade, how can they sustain their positive mathematics identities as they progress through education? Research notes many African American students are tracked into lower level courses (e.g., Berry et al., 2013) and many minorities do not pursue or are kept from pursuing more advanced mathematics (e.g., Martin, Gholson, & Leonard, 2013). When does this trend begin? And more importantly, what happens in the classroom to help accelerate African Americans' disassociation with mathematics? A longitudinal examination could be informative to answer these questions as students progress from third grade to middle school.

Furthermore, research on how teachers utilize or marginalize students' multiple identities in the mathematics classroom could be informative in the mathematics equity literature. As Aguirre, Mayfield-Ingram, and Martin (2013) argued:

> Student identities are diverse and complex. They can be faith-based—strong Muslim or Christian identities, perhaps—and family-based—identities as "good sons" or "good daughters," for instance. Identities of young people can also include early identifications with careers as doctors, lawyers, teachers, engineers, or sports professionals, for example. These identities are important; they can serve as sources of strength and motivation to do well in school, in general, and in mathematics, in particular… [Children's] developing identities should be important considerations in the daily work of all teachers… [as teaching mathematics involves] supporting students' coming to see themselves as legitimate and powerful doers of mathematics. This understanding of children's identities, especially in relation to mathematics, can give teachers a better understanding of how and why some students make positive connections with mathematics and others do not. (p. 14)

This research could help answer some of the previously raised questions, such as why and when students begin to disassociate with mathematics.

Finally, following Wood's (2013) call, more research is needed to differentiate between macro and micro mathematics identities. Macro identities have been the focus of much of the research. These studies focus on big picture mathematics identities, not on how they change in the minute interactions within the classroom. While this study takes the macro identity perspective, I have attempted to look at specific classroom interactions and experiences as factors that influence students' mathematics identities. More work is needed to make the connection between classroom interactions and students' generation of micro and macro mathematics identities. My work in this study used positionality, specifically ways students position themselves or are positioned in the classroom in terms of being a successful mathematics student, as one theoretical construct for examining the connection between macro and micro mathematics identities.

Significance

A recent article in *The Atlantic* discussed the African American education experience in relation to the nomination of an individual to be Secretary of the United States Department of Education. In the article, Jon Hale (2017) noted, "American history clearly demonstrates that communities of color have been forced to rely upon themselves to provide an education to as many students as possible. Students of color have rarely been provided a quality public education" (n.p.). Unfortunately, this marginalization has not only been in public education, but also in the mathematics research literature. While studying mathematics identity has led to more research on successful African American students in mathematics (Jackson & Wilson, 2012), historically, research concerning African Americans in education possesses a dominant narrative of discourses of deficiency and rejection (Stinson, 2006). Through this study, I attempted to provide counter narratives that not only focus on African American students' experiences, but also focus on successful African American students.

The experiences of the two third graders highlighted in this study, Janae and Kayla, offer very different perceptions and very different paths to success within the same mathematics classroom. While Chapter 4 explored these different paths and positions, the study is significant in that their success and positive mathematics identities are a focal point in the study. Moreover, by focusing on elementary students' experiences, I am addressing a significant gap in the mathematics education literature. Many studies on mathematics identity have not focused specifically on African American elementary students. Boaler and Greeno (2000) reviewed AP Calculus students' experiences. Martin (2000) focused on African American junior high and adult learners. Berry's studies focus on African American middle school boys. Hodge (2008) studied elementary students, but the population was more affluent and contained only one African American student. Thus, by prioritizing African American elementary students' experiences, this study contributes to a severely limited area in the research literature.

Finally, in the research design, analysis, and writing, I prioritized student voice. Zavala (2014) explained her process:

> Solorzano and Yosso (2002) outline what they call a 'critical race methodology' for education, which focuses on the stories and experiences of students of color. They propose scholars can use the *counterstories* offered by students of color as they share their *testimonios* as a tool for exposing, analyzing, and challenging the majoritarian stories of racial privilege. Testimonio privileges the experiences of people marginalized by institutions such as schooling within a U.S. context. (p. 62)

Although I did not explicitly follow the critical race methodology, the emphasis on privileging the experiences and voice of traditionally marginalized populations, in this case elementary African American students, was important throughout the study. Similar to how many populations of color or children from poverty are marginalized from being positive topics in the research literature, their voices are even less represented. This study makes a significant contribution to the literature in providing the experiences of mathematically successful African American students in their voice.

Taken as a whole, this study makes a significant contribution to the literature on African American students' mathematics identities. As discussed in Chapter 1, this study has several limitations. There were only three participants. The video collected only touches on a few days of instruction in one grade in one school. While these limitations exist, the implications for the classroom and for future research provide springboards for further studies to investigate the experiences of African Americans in the mathematics classroom and how those experiences shape their mathematics identities. Throughout the study, I have looked at the student experiences in the classroom with an eye toward achieving the Access and Equity Principle. Ms. Madison's classroom was only one classroom in one school, serving about 90 students of the millions of students in the United States. Of those 90 students, I examined the experiences of three. While each student in the classroom experienced mathematics class differently, the factors identified in contributing to their positive mathematics development—a strong instructional emphasis on the Standards for Mathematical Practice, positioning students positively through interactions and tasks, and helping students maintain a growth mindset—provide a beginning conversation on moving toward more positive classroom mathematics experiences for African American students.

APPENDIX A: Math Questionnaire

Adapted from (Whitin, 2007)

Name:_________________ Date: ____

Please answer the following questions to the best of your ability.

1. To be good in math, you need to __________ because ________________.

2. Math is hard when ___________.

3. Math is easy when ___________.

4. How can math help you?

5.The best thing about math is _____________.

6. If you have trouble solving a problem in math, what do you do?

Tell anything else you want about math.

Draw a picture that shows what math means to you.

APPENDIX B: INTERVIEW PROTOCOLS

All interviews were semi-structured with follow up questions being asked based on answers to the questions. The major questions are included here.

Student Interview 1

- If someone didn't know you, how would you describe yourself to that person?
- How would you describe yourself as a student? (Zavala, 2014)
- How would you describe yourself as a math student?
  - Refer to responses on qualitative questionnaire for follow ups
  - What does it mean to be successful in math?
  - What does it take to be successful?
  - Do you know someone who is successful at math?
    - Tell me about that person
- What is your favorite part of math class? Least favorite? Why?
- Tell me about the best math teacher you have had.
  - What made that teacher the best?
- How can you help yourself learn mathematics?
- How can your teacher help you learn mathematics?

Student Interview 2 (stimulated recall)

- Can you tell me what you were doing in this video?
  - What was your role?
  - How did you interact with other classmates?
  - What did your teacher do?
  - How did you solve this problem?
  - Is this an activity you usually do in math class?
- Do you think you were learning mathematics here?
  - How so?
  - What were you doing to help you learn math?
  - What topics were being covered?
- What did your teacher do to help you learn math here?
  - Was it helpful?
  - Is there another way you would have liked to learn about this topic?

Student Interview 3

- How do you learn math best?
  - What do you have to do?
  - What do you need your teacher to do?
- What activities do you think help you learn math best? Least? Why?
  - What happens in each activity to support you?
- What do you like best about how your current mathematics teacher teaches? Least? Why?
- If you could tell a new math teacher anything, what advice would you give them?

Teacher Interview

- Tell me about yourself and your journey to being a teacher at Wildcat Academy
    - What were your experiences in math?
    - How have your different experiences compared?
    - How have your experiences informed your current approach to teaching mathematics?
- How would you describe your approach to teaching mathematics?
    - Important strategies?
    - Reform vs traditional?
    - What are students expected to be doing during your lesson?
    - How do you use the standards in your instruction?
- How do you build relationships with students?
    - Importance? Why?
- What does it mean to be a good student in math?
    - Specific characteristics?
- Would you describe _______ as a good student?
    - Why/not?
    - Root cause?
    - How could this student improve?
    - What is your role in helping him/her improve?
- Is there anything else you want me to know about your mathematics classroom?

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Education

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2012-2013 **Harvard University, Graduate School of Education**
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2010-2012 **Walden University**
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2004-2008 **University of Kentucky**
B.A. in Economics with departmental honors, summa cum laude
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Publications

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*Jackson, C., Mohr-Schroeder, M., Cavalcanti, M., Albers, S., Poe, K., Delaney, A., Chadd, E., Williams, M., & **Roberts, T.** (accepted). Prospective mathematics teacher preparation: Exploring the use of service learning as a field experience. Submitted to Fields Mathematics Education Journal.

Roberts, T. & Chapman, P. (2015). Express yourself: Using digital technology for meaningful communication. *Children's Technology and Engineering*, *20*(2), 22-24.

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Presentations

National

Roberts, T. (accepted). *Perseverance, precision, and mathematics identity: Janae's experiences learning mathematics in a third grade classroom*. Paper session at the American Educational Research Association's 2017 Annual Meeting, April 27-May 1, San Antonio, TX.

Roberts, T. (2017, April). *Comparing mathematics identities of two African American third graders: A case study*. Poster to be presented at the 2017 Research Conference of the National Council of Teachers of Mathematics, San Antonio, TX.

Roberts, T. & Brusic, S. (2017, March). *Best STEM books: Engaging students through literature*. International Technology and Engineering Educators Association's 79th Annual Conference, Dallas TX.

Roberts, T. & Jones, V. (2017, March). *Children's Technology and Engineering Journal*. STEM Showcase presentation at the International Technology and Engineering Educators Association's 79th Annual Conference, Dallas, TX.

Roberts, T. (2016, October). *Classroom influences on young African American learners' mathematics identities*. Research session at the School Science and Mathematics Association 2016 Convention, Phoenix, AZ.

Schroeder, D. C., Jackson, C., Mohr-Schroeder, M. J., Powers, L. B., Albers, S., Poe, K., **Roberts, O. T.,** Blyman, K., & Cavalcanti, M. (2015, April). *Tapping the potential of struggling learners of mathematics: Instructional Strategies*. Gallery workshop at annual meeting of the National Council of Teachers of Mathematics, Boston, MA.

Roberts, T. (2015, February). *Exploring African American elementary students' mathematics identities*. Research Council on Mathematics Learning Conference, Las Vegas, NV.

Mohr-Schroeder, M. J., Jackson, C., Schroeder, D. C., **Roberts, T.**, Cavalcanti, M., & Blyman, K. (2015, February). *Using informal learning environments to prepare preservice teachers to work with struggling mathematics learners*. Annual conference of the Association of Mathematics Teacher Educators, Orlando, FL.

Schroeder, D. C., Jackson, C., Mohr-Schroeder, M. J., Blyman, K., **Roberts, T.**, Cavalcanti, M. (2014, Novembr). *Motivating and inspiring middle level students' interest in STEM via STEM Camp*. School Science and Mathematics Association 2014 Convention, Jacksonville, FL.

Jackson, C., Mohr-Schroeder, M. J., Schroeder, D. C., **Roberts, T.**, Blyman, K., & Cavalcanti, M. (2014, November). *Preparing preservice teachers to work with students who struggle in mathematics*. School Science and Mathematics Association 2014 Convention, Jacksonville, FL.

Roberts, T. & Chapman, P. (2013, May). *Students learning by creating*. National Science Teachers Association STEM Forum & Expo, ST. Louis, MO.

Roberts, T. & Chapman, P. (2012, May). *Discovering STEM through innovation days*. National Science Teachers Association inaugural STEM Forum & Expo, Atlantic City, NJ.

Siders, T. & **Roberts, T.** (2011, May). *S.H.O.U.T.ing out your magnet theme*. Magnet Schools of American National Conference on Magnet Schools, Indianapolis, IN.

State and Regional

Roberts, T. (2016, February). *Classroom influences on mathematics identity: Developing case studies of young African American learners*. Annual Conference of the Eastern Educational Research Association, Hilton Head, SC.

Albers, S., Poe, K., Blyman, K., Cavalcanti, M., **Roberts, T.**, Schroeder, C., & Mohr-Schroeder, M. J. (2015, April). *Using informal learning environments to prepare preservice teachers to work with struggling mathematics learners*. Kentucky Mathematics Educator Development Inaugural Conference, Richmond, KY.

Chapman, P. & **Roberts, T.** (2013, March). *Bridging the gap: Building literacy through STEM*. Scaling STEM Conference, Durham, NC.