

ABSTRACT

TRAVIS, CRYSTALL SHAREE. Analyzing What African American Students Articulate as Lesson Goals: Assessing Their Interpretations of Lesson Objectives with respect to Instructional Representations used in the Science Classroom (Under the direction of Eileen R. Carlton Parsons).

The focus of this research was to identify the information African American students articulated from science lessons. This knowledge was obtained from the students' interpretations of objectives in regards to instructional representations implemented to teach science concepts. Because of the benefits available to educators, this study utilized action research as a methodology for data collection. My involvement as both the classroom science teacher and researcher allowed me to use the sixth grade students I taught as participants in this work. Though all of the students who attended my science class were exposed to the same teaching and use of instructional representations, only information from the thirty-eight African American students was analyzed for this research. Data was collected after classroom instruction and exposure to different instructional representations. Information was gathered through students' responses on feedback sheets. This information allowed me to observe the extent to which students' articulations of lesson goals aligned with the objectives for the lessons. It also allowed me to determine if this alignment varied with the instructional representations used to teach the objectives. The results showed that differences existed between the educator's objectives for the lesson and students' interpretations of the content. Additionally, data revealed variations in alignment with respect to the instructional representations employed.

**ANALYZING WHAT AFRICAN AMERICAN STUDENTS ARTICULATE AS
LESSON GOALS: ASSESSING THEIR INTERPRETATIONS OF LESSON
OBJECTIVES WITH RESPECT TO INSTRUCTIONAL
REPRESENTATIONS USED IN THE SCIENCE CLASSROOM**

by

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A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Master of Science

MATHEMATICS, SCIENCE, AND TECHNOLOGY EDUCATION

Raleigh

2004

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DEDICATION

I would like to dedicate my graduate and thesis work to my mother, Stephanie Travis, sisters, Dr. Stacie Moore and Sharrone Travis, and brother, Clyde Travis IV. My mother's tireless work as a single mother shows her commitment to improving her children's lives through her support of their education. Stacie's accomplishments as a successful optometrist inspire me to set my goals high and to strive to achieve them. Sharrone, a fellow educator, provides me with direction, guidance, and a listening ear. Her successful completion on her master's degree in elementary education motivates me to continue on with my education in an effort to improve my classroom instruction. Clyde, a student at the University of Nebraska at Omaha, shows how diligence and commitment to your education could carry you through difficult times. I extend thanks to all of you for loving and supporting me. We all acknowledge that it is not because of our efforts, but our faith in God that has allowed for our many successes and blessings.

BIOGRAPHY

Crystall Sharee Travis was born in Omaha, Nebraska on August 26, 1978. Her mother, Stephanie, and a host of extended family members, including grandparents, aunts, uncles, and cousins, helped to raise her and her three siblings. Crystall grew up with a passion for studying science and a desire for working with children.

Ms. Travis attended elementary, middle, and high school in Omaha. She graduated in the top 15% of her high school class in 1996. Upon graduating from high school, Crystall received several full-tuition academic scholarships to continue her education. She elected to attend the University of Nebraska at Omaha. At this institution, she majored in biology/ pre-medicine. Though she was extremely successful in this program, she changed her major to elementary education during the first semester of her junior year. She states that her decision to change her major was a part of her “life’s purpose allowing her to use her God-given talents”. This change in major and her high academic achievements resulted in her selection as a Bill Gates Millennium Scholar during her senior year. This scholarship later provided Crystall with the opportunity to continue with future academic endeavors.

After graduating from UNO, Ms. Travis taught eighth grade science at King Science Center in Omaha for one and a half years. This was a wonderful experience for her, especially considering the fact that she attended this school as a student. Former educators were now her co-workers. They provided her with models of teaching excellence. Her work at this magnet center helped to develop her teaching skills and ability to work with children.

Recognizing that additional knowledge could help her to grow professionally, Crystall left her teaching position in 2002 to continue her education. She utilized the Gates Millennium scholarship and pursued a master's degree in science education at North Carolina State University in Raleigh, NC. Her relocation to North Carolina opened the door to new challenges. As a graduate student, she gained more information about effective teaching strategies and had the opportunity to put these theories into practice through her work as a sixth grade science teacher. These experiences combined to help her reach her goal of becoming a master teacher. Crystall looks forward to the new possibilities ahead of her.

AKNOWLEDGEMENTS

I would like to extend gratitude and appreciation to the following individuals:

Thank you to the Lord who is my savior and redeemer. Thank you for equipping me with the necessary tools to confront all of life's challenges. Thank you for being there for me when times were rough and for giving me your Word as a reference of hope and encouragement. I know that it is by your grace and mercy that I was able to make it to this point in my life. I will always live my life as your faithful servant.

Again, I would like to acknowledge my family for providing me with a support system and a model of successful individuals. Thank you for loving and encouraging me and respecting my life and decisions. Mom, Stacie, Sharrone, and Clyde, I love you. To all of my extended family members, I am grateful to you for providing me with additional support, love, and care. My grandparents, aunts, uncles, and cousins, I thank you for everything you have done for me.

I would also like to take the opportunity to thank my friends. You all loved me as if I were family. Several individuals have been my friends for a number of years and have gone through many of life's experiences with me. Included in this group are Tamika, Yolanda, Sharyn, Glenda, and Nicole. I cannot forget the other friends I have recently made. Our developing friendships have allowed me to become acclimated to a new city, university, and teaching position. You have encouraged and supported me through my range of emotions. I gladly thank Earl, Rebecca, Tina,

Tracie, Sharon, and Porsche. I pray that all of my friends and family members have a blessed future.

As an educator, I cannot forget the wonderful teachers and professors I have had throughout my years in school. From elementary through graduate school, I was blessed with educators who genuinely cared about my future. I am grateful to Mrs. Brown for helping me to appreciate education and encouraging me to follow a successful path. Dr. Mitchell, Dr. Thompson, and Mr. Black, thank you for helping me through my years at UNO. Your support truly inspired me to make it through. Special appreciation goes to Dr. Irvin who recognized the possibilities in me and recommended me for the Bill Gates Millennium Scholarship. You have been such a blessing to my life.

Finally, I must acknowledge the awesome professors I have relied on at NCSU. Dr. Parsons, you are truly a positive role model for African American women. You motivate me to achieve all of my goals and to set a standard high above the rest. I am grateful for having you as my professor, committee chair, and sister in Christ. I could not have made it through this process without your support and dedication. Dr. Park, you were one of the first individuals I communicated with in North Carolina. Thank you for welcoming me into the graduate community at NC State. Your attitude exudes warmth. Dr. Xiang, I am grateful to you for your willingness to participate on my committee. Thank you for challenging me in Systematic Botany and helping me to develop a deeper appreciation for plants and nature. Dr. Carter, thank you for being an excellent instructor and helping me to acquire the necessary tools to become a master teacher and researcher.

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Chapter I

Problem

Introduction

Imagine classrooms where all of the students are high achievers, effortlessly grasping content and concepts when they are initially presented. In such settings, there is no need for remediation or re-teaching. The students are successful on every assignment, project, and test. They are eager to complete extra credit activities. In this environment, educators share the belief that all children have the ability to learn and are able to be successful in school. Such teachers eagerly look at all of their students as unique individuals and welcome their prior experiences and knowledge. They understand that the information the students possess and bring into the classroom will impact students' attitude and achievement. These educators do not possess bias toward children from different genders, cultural, ethnic, or socioeconomic groups. Instead, they welcome their students' differences and regard them as vital to the overall culture and climate of the classroom.

Ideally, this depiction would represent every classroom. However, such a setting only exists in a utopian society. The reality is that classrooms are extremely diverse. This diversity is true in regards to gender, race, ethnicity, economic backgrounds, and ability levels. Every student enters the classroom with distinct capabilities and various degrees of knowledge affecting their levels of success. These academic differences are often influenced by the student's abilities or disabilities, educator beliefs and biases, parental involvements, and cultural values. An educator naturally expects differences in students' accomplishments. Yet, one must question

when extreme variations in achievement become too distinct, especially when patterns emerge showing differences in abilities coinciding with racial demographics. Do such discrepancies reflect individual weaknesses or do they depict a larger social problem? When should these gaps in achievement spark concern?

Nationally, apprehension has continued to rise in regards to the divergence in academic achievement between African American and Caucasian students. Current research shows that black¹ students are achieving at a significantly lower rate than Caucasian students (National Center for Education Statistics-NCES, 2001). As an African American woman and an educator, I, too, am disturbed by this difference in students' levels of success; therefore, I elected to use my research as an opportunity to investigate one factor affecting African American students' achievement. I examined African American students' interpretations of content with respect to instructional representations used in my urban science classroom. The specific questions I used to guide my research were:

- ❖ With regard to lesson goals, how closely do the African American students' interpretations align with the instructor's intended objectives?
- ❖ Does this alignment in interpretation vary with the instructional representations employed by the instructor?

Targeting African Americans for this research will help me to understand the extent to which the black students are able to articulate the goals that are intended for the lesson and if this articulation varies with the mode of instructional representations used to teach. I believe this knowledge about instructional representations can

¹ Black and African American are used interchangeably throughout.

provide insight into possible reasons for the lower achievement rates for African American students, who largely populate urban educational settings.

Nature of Instructional Representations

When studying science, students often encounter concepts that are abstract and difficult for them to comprehend. They filter the science information through their individual prior knowledge and formulate meanings that are unique and personal. The result can be alternative conceptions. To reduce these misconceptions, educators attempt to communicate concepts by using a wide selection of instructional representations to present science material (Hashweh, 1987). The instructional displays they choose often reflect new and innovative methods. These methods help to explain, clarify, and represent various science phenomena (Wu, Krajcik, & Soloway, 2001).

It is important to look at instructional representations when addressing the issue of the achievement gap because they can provide insight into how students are interpreting and articulating information gained from tools used in the classroom. Considering that a number of urban educators are still relying heavily on lecture-based instruction, insight into other instructional representations can be extremely beneficial. Research shows that the primary use of lecture-based instruction is typically due to the fact that class sizes are large and resources are limited (Luft, 1998). These factors influence educators' use of teaching strategies directed at the whole class (e.g., lectures, class readings, completing worksheets) rather than

providing instruction that addresses an array of student abilities and needs (Hewson, Kahle, Scantlebury, & Davies, 2001).

Because African Americans largely populate urban schools, frequent use of lecture-based teaching has a number of limitations that are often detrimental to the achievement of these students (Tobin, Roth, & Zimmerman, 2001). One limitation is that the lecture method is teacher-focused. It places students in the role of passive receivers of knowledge and emphasizes the instructor's delivery of information and concepts. Students have few opportunities to provide input or feedback. Consequently, lecture fails to incorporate group work and other student-centered activities.

Another limitation of lecture and other forms of teacher-centered instruction is that it typically focuses on memorization and low-level science process skills. Lecture restricts the number of occasions for students to develop and use high-order skills such as analysis or synthesis. When students are not exposed to instruction that reinforces these higher order skills, their science knowledge and achievement suffers. Since African American students tend to populate learning environments where memorization and other low-level science process skills are emphasized, they are placed at a disadvantage that impacts their success in school, further adding to the achievement gap.

Background of the Problem

Prevalence of the Achievement Gap

Before reviewing additional information about instructional representations, it is necessary to clarify the problem: the unequal achievement rates between black and white students. In education, the theme of equity is ever-present. To address the achievement gap, the nation made a commitment to provide equity in science education, a resolution to address unfair practices in the areas of instruction and assessment. Equity, which Atwater (2000) has described as the quality of being fair and impartial, attempts to equalize the learning field and ensure maximum levels of success for all students. Such efforts include, but are not limited to, the elimination of tracking and the implementation of standards-based curricula (Seiler, 2001a). Though efforts to promote equity are implemented, these strategies to equalize learning and promote success continue to fail. A substantial gap in academic performance between certain ethnic groups, specifically between Caucasian and African American students, persists (Meehan et al., 2003; Norman, Ault, Bentz, & Meskimen, 2001).

A historical view of the 20th century reveals that disparities in achievement are not unique to African American and Caucasian students. Research has shown that previous gaps in academic achievement existed between native-born European Americans and groups other than African Americans. Such groups include Polish, Jewish, and Italians (Norman et al., 2001). Compared to the native-born European Americans, students from these other ethnic groups performed poorly. Incidentally, this time marks a point in history when African Americans were more successful in

school than most white immigrants. However, as European immigrants successfully assimilated into American society, acquired better jobs, and obtained higher positions of status, their achievements in education increased. As a result, the differences in achievement between native and immigrant European Americans diminished and eventually disappeared (Norman et al., 2001). Norman et al. (2001) have argued that an ethnic group's sociocultural status is linked to its scholastic performance. Because of increased access to resources and opportunities, a reduction in the achievement gap coincided with a rise in certain ethnic group's sociocultural status. In this work, Norman et al. (2001) have identified that the opposite pattern existed for African American students:

During Reconstruction school attendance among Blacks as well as the per capita spending on Black schools was roughly equal to that for Whites...In some instances, Black achievement and attendance also exceeded that of native Whites. This pattern of Black scholastic performance persisted from emancipation through roughly the third decade of the 20th century. When the Reconstruction effort was effectively abandoned in 1877, per capita spending on Black schools fell to 30% of that for Whites. This disparity in education expenditure and economic opportunities ushered in a period of declining attendance and enrollment patterns for Blacks. This decline has persisted in today's achievement gap (p. 1105).

History reveals that as black Americans were limited in their access to jobs, their sociocultural status fell, and they were restricted in educational opportunities. Subsequently, their academic achievement declined. The previously described pattern continues in America.

In today's society, the issue regarding the achievement gap between minority and Caucasian students remains a topic of much speculation, research, and debate in education (Norman et al., 2001). The African American population is of

interest because this group comprises a considerable number of minority students whose science achievement substantially trails white children (Hrabowski, 2002). Evaluation of unsuccessful student achievement on state and national assessments (e.g., state reading and mathematics exams, Scholastics Assessment Test) led to a renewed focus upon African American students (Kober, 2001). Table 1 displays test averages for white and black students on the Scholastic Assessment Test (SAT) from 1998 to 2002; the data were obtained from the NCES (2002). This information illustrates evidence of a gap in achievement between black and white students.

Table 1
Scholastic Assessment Test Averages by Race/Ethnicity 1998-2002

Race/Ethnicity	1998-99	1999-00	2000-01	2001-02
SAT-Verbal				
White	527	528	529	527
Black	434	434	433	430
SAT-Mathematical				
White	528	530	531	533
Black	422	426	426	427

Scholastic Assessment Test was formerly known as the Scholastic Aptitude Test. Possible scores on each part of the SAT range from 200 to 800.

Research has shown that the difference in the success rates of black and white students as illustrated in the SAT scores is not an isolated event affecting only one region in the country. This disparity continues to exist across school districts and

counties throughout the United States (Seiler, 2001a). Furthermore, the gap in achievement is apparent regardless of students' socioeconomic status or residential location. Inequalities that persist between black and white students' performance have been observed in lower, middle, and upper-class schools (Meehan et al., 2003; Hewson et al., 2001). Additionally, the black-white achievement gap is just as significant for students of college-educated parents as it is for students of less-educated parents (Kober, 2001). Finally, the gap in success rates is visible across subject areas.

Nature of the Achievement Gap in Science and Math

Though the gap in student achievement is apparent in all subjects, it is most prominent in the areas of mathematics and science (Hrabowski, 2002). Changes in national ethnic demographics and the demands for mathematical, scientific, and technological literacy, require educators and administrators to take a more active role in equipping minority children for the future. Because the population of African American and other minority groups is steadily growing, efforts need to be made to eradicate the achievement gap.

As stated by Luft (1998), the nation's largest school districts report a majority population of African American, Native American, and Hispanic American students. The percentage of minority students continues to increase in the 25 largest school districts in the United States including: New York City Public School District (82%), Dade County-Miami- Public School District (83.3%), and Los Angeles Unified School District (87%; Luft, 1998). Such growth in minority populations will

naturally have a significant impact on education, especially in the science classroom. Despite the push towards inquiry and constructivist learning, science instruction does not provide minority students with opportunities to do science. Furthermore, students do not find the instruction to be relevant to their daily lives.

Achievement Gap at Different Educational Levels

An additional issue with this problem is that the gap in student achievement is present at all levels of education. From pre-school to college, African American students are performing at a level sub-standard to their Caucasian peers. Past studies have attempted to determine both the origin and nature of the achievement gap during children's years in education. Startling results have revealed that the disparities in success are not unique to school-aged African American and Caucasian students; the achievement gap is observed prior to students entering grade school (Kober, 2001).

The U. S. Department of Education conducted research that identified that only 57% of African American children entering kindergarten could recognize letters in comparison to 71% of Caucasian children (Kober, 2001). This study also discovered that African American students begin kindergarten trailing Caucasians in early math skills such as recognizing numbers and shapes, understanding relative orders of objects, and performing simple addition and subtraction problems (Kober, 2001). If no interventions are made, the difficulties experienced at the pre-school and kindergarten levels will persist in subsequent grades, placing African American students at a lower academic level than their Caucasian peers.

Not only is this gap in student's success apparent during pre-school or kindergarten, but a difference in achievement is also recognized during the elementary years. The 2001 National Assessment of Educational Progress (NAEP) has shown that the fourth grade proficiency scores of African American students were significantly lower than other ethnic groups (Taylor, 2002). Over the four-year period reported in this study, black students' scores were drastically lower than students from Caucasian, Asian, Hispanic, and Native American backgrounds (Taylor, 2002). Additionally, reports by the NAEP have indicated that students from low socioeconomic backgrounds and African American descent were academically two years behind other students, specifically white children, by the time they entered the fourth grade (Robelen, 2002).

Research has also identified that this variance in success between black and white students increases as children matriculate through the education system (Seiler, 2001a). This implies that the differences in achievement observed in the elementary ages persist through the junior high and high school years. NAEP reports for 1998 have identified that a 40-point achievement gap existed in eighth grade mathematics between Caucasian and African Americans. Consequently, only 5% of the nation's eighth grade African American students scored at the proficient level or above in mathematics compared to 34% of their Caucasian peers (Meehan et al., 2003).

In 1999, only 1 in 100 African American high school seniors could read and comprehend specialized text (i.e., a newspaper's science section) while 1 in 12 Caucasian students could complete this same task successfully (Haycock, 2001). This study has further explained that 1 in 10 whites, compared to only 1 in 100

blacks, could easily solve an elementary algebra problem (Haycock, 2001). Finally, the research conducted has found that by the end of high school (12th grade), a number of African American students had reading and mathematics skills equivalent to those of white students in the eighth grade (Haycock, 2001).

Naturally, black students' poor performance in high school affects this population's graduation rates. Statistics from 1998 have shown that only 73% of African American students completed high school compared to 82 % of Caucasians (Hrabowski, 2002), further revealing that the disparities adversely affecting black students during formative learning years extend post high school.

Effects are specifically evident in regards to college admission and future career opportunities available to African Americans. In 1998, only 41% of African American students were enrolled in college. This number is in contrast to 50% of Caucasian students (Hrabowski, 2002). Of the students in college, African Americans were half as likely as whites to earn a bachelor's degree by the age of 29 (Haycock, 2001). Consequently, the lower numbers of black students enrolling in college, succeeding, and graduating is a direct reflection of their past educational experiences.

Impact of the Achievement Gap

African American students' past failures in elementary and secondary education make them ineligible for certain colleges and programs of study (Atwater, 2000). With respect to the percentage of African Americans residing in the United States, few have the grades and standardized test scores needed to compete for

college and university admissions (Hrabowski, 2002); therefore, a low percentage of African American students are entering college, studying science, and obtaining advanced degrees in science-related fields.

The NCES has reported that during the 2000-2001 school year African American students accounted for only 11% of the associate's, 9% of the bachelor's, 8% of the master's, 5% of the doctoral, and 7% of the professional (M.D., D.D.S., J.D.) degrees obtained. Table 2 shows statistics for the field of study, level, and percentage of degrees conferred to African American students in science and math. These figures show that the achievement gap between African American and Caucasian students does not result in equitable levels of science degree attainment. Clearly, pre-college differences in educational achievements have post-high school effects.

Table 2
Field of Study, Level, and Percentage of Degrees Conferred to African Americans During 2000-2001

Field of Study	Level			
	Associates	Bachelors	Masters	*Doctorate
Biological/Life Sciences	9	8	5	2
Engineering/ Related Technologies	11	6	3	2
Health Professions/ Related Sciences	11	10	7	4
Physical Sciences/ Science Technologies	11	6	3	2
Mathematics	7	7	4	2

* Doctorate includes Ph.D., Ed.D., and comparable degrees at the doctoral level. It excludes first-professional degrees, such as M.D., D.D.S., and law degrees.

The achievement gap that affects African American students during college also affects these students when they enter the workforce. Because society continues to move in the direction of mathematics, science, engineering, and technology, a number of black students are at a tremendous disadvantage. In order to be successful in these fields, individuals must receive adequate science and math education and training. However, the current status of education shows that the majority of the minority student population, including African Americans, will not be prepared to accept such positions (Hrabowski, 2002). If successful strategies are not implemented to reduce the gap in achievement and adequately educate black students in mathematics and science, a significant percentage of the United States population will be unable to productively contribute to the workforce that is projected to expand by 12.3% (Hrabowski, 2002).

Not only does education affect the employment opportunities available to African Americans, but it also affects future finances and income. Individuals who obtain advanced levels of education also receive higher salaries and increased financial gains (Robelen, 2002). Robelen (2002) has speculated that the achievement of black students during the K-12 school years appeared to be highly correlated with their success in college and the workforce. When one considers the relationship between achievement and economic status, black students who are unable to achieve academic success are likely to acquire lower paying jobs. Clearly, one can see how

the dichotomy in achievement between African American and Caucasian children can have a lasting impact on students throughout their lives.

Factors Contributing to the Achievement Gap

Tracking

When analyzing the achievement gap between African American and Caucasian students, researchers examine various factors that contribute to the problem. One factor is tracking. Tracking uses ability to identify students and subsequently place them in divergent pathways of education (Goodlad & Oakes, 1998; Luft, 1998).

The resulting tiers for learning characteristically involve a lower track of students often believed to require retention and remediation. This population typically consists of those students who have been classified with learning disabilities and behavior disorders (Luft, 1998). Unfortunately, African American children, especially males, have been placed in this track at disproportionate rates (Oakes, 1995). African American students typically find that their initial placement in lower tracks results in subsequent placement in these groups school year after school year (Goodlad & Oakes, 1998). Though school districts attempt to honor parents' requests to change students' placement from lower to higher tracks, African American parents have limited access to and knowledge of policies enabling this change (Oakes, 1995). As a result, black students remain in low track classrooms. In this environment, students have restricted learning opportunities (Norman et al., 2001).

A second track includes those students performing at the expected grade level. These children set the norm by which other students are compared. They typically are educated with resources and materials appropriate for their age and ability group (Luft, 1998). The final, highest, track classifies students who are performing above their expected grade level. They are identified as academically gifted and often placed into classes labeled “honors” and “advanced placement”. This set of students receives access to experiences and materials geared at advancing them beyond the average student. Teachers of students in higher tracks are often more enthusiastic and eagerly seek parental and community support (Goodlad & Oakes, 1998). They expose their students to more resources and opportunities than students in lower tracks.

In regards to tracking, one would think that such a system of grouping students by ability would produce an abundance of academic benefits. However, the unfortunate result of this differentiation is a difference in access to science curriculum and instruction. Tracking creates an environment where advanced science exposures are exclusive to students in higher tracks. Such elitist practices produce a segregated student body (Oakes, 1995). Not only is this segregation apparent on the academic level, but also segregation is evident according to race (Atwater, 2000).

Despite the racial make-up of a school, tracking produces segregated settings. Atwater (2000) has noted that at predominantly African American schools few black students were enrolled in the honors or advanced placement classes. Because African American students are disproportionately placed in the lower track

while larger portions of Caucasian children are assigned to the higher level (Tate, 2001), black students experience restrictions in their science experiences. These restrictions contribute to the science achievement gap because students matriculating through the lower tracks receive inferior learning opportunities in comparison to those students advancing through the higher track (Atwater, 2000).

In brief, tracking practices significantly affect the diversity in science classrooms. Research has verified the differential impact tracking has on black and white students' success rates and the black-white achievement gap.

Influences of Student Self-Perception

Another contributing factor to the achievement gap is student self-perception: black students do not see themselves in science. Viewing self as an outsider to science affects the students' self-confidence and often produces the perception that black people cannot be successful in science (Atwater, 2000). The lack of science self-confidence that African American students experience may be the result of poor multicultural lesson planning on the part of the teacher. Insufficient planning from a multicultural perspective may leave black students observing science as a predominantly white field that excludes people of color.

Studies have shown that students typically view the science discipline as one reserved primarily for white males (Luft, 1998). This student-held belief was recognized when students were asked to sketch their image of a scientist. Repeatedly, students sketched pictures of Caucasian men in lab coats. Their images

further showed that the black students believed they are unable to do science and experience success in this field.

When cultural examples and the contributions of minorities to science are infused into the educational experience, African American students will be able to relate to what is taught. They will envision themselves as part of the scientific enterprise and be encouraged to perform at higher levels (Luft, 1998; Tuan, Chin, & Tsai, 2003), thereby, alleviating the students' negative self-perceptions regarding science.

Influences of Parental Views

Not only is the achievement gap influenced by the students' self-perception, but it is also affected by the views of individuals surrounding students. Some of the views that significantly impact the success of students often come from their parents (Barton et al., 2001; Luft, 1998). Parents' outlooks influence how they support their children in science learning. Unfortunately, a number of African American parents hold pessimistic views of science. These opinions are often the result of their own negative past science experiences (Barton et al., 2001). Additionally, some black parents do not view science as a relevant subject, one from which their children will benefit later in life. I contend that these parents do not provide adequate support for science learning and this lack of support further adds to the disparity in black and white student achievement.

In a number of black households, parental indifference to science is extremely apparent (Barton et al., 2001). These parents view science as a subject that

does not have post-high school benefits for their children. What they fail to understand is that if they begin to value science and instill this appreciation in their children, opportunities for future successes will emerge (Seiler, 2001a).

As well, parents need to realize that they are already actively involved in science at home (Barton et al., 2001). From measuring and mixing ingredients for cooking to working in the backyard vegetable garden, parents and students are exposed to science in their daily lives (Barton et al., 2001). Students can apply the concepts of formal science education such as biology, chemistry, and physics to these informal science exposures. When parents understand that these basic activities involve scientific concepts, they will see how easy it can be for them to incorporate science learning into the daily lives of their children. By altering their personal images of science and recognizing its relevance to life, African American parents can more positively impact their children's science learning.

In other cases, circumstances rather than views of science prevent parents from supporting the science learning of their children. A large number of black students are raised in single parent, mother-led homes. In situations where one parent is the sole caregiver and provider for the children, a number of issues arise resulting in a lack of parental involvement. Studies have shown that single parents often have an array of factors that hinder them from being active participants in their children's education. These obstacles to parental involvement include the following: problems with transportation, limits to financial and material resources, barriers of language and education, preoccupations with other children, and constraints of time (Barton et al., 2001). Though a number of these parents may want to assist their children and

encourage them to be successful in science, circumstances may make such support improbable.

Whether parents are able or unable, willing or unwilling to support the science learning of their children, research has indicated that parental support affects science achievement. Literature has revealed that households in which parents are actively involved in science learning produce children who are more successful in science than their peers who do not have this support (Barton et al., 2001). As such, efforts to enhance parental support in the learning of science by altering the science views of parents and by addressing some of the obstacles to parental involvement seem necessary in alleviating the black-white achievement gap.

Expectations of Educators

Teacher expectations also influence the achievement gap that exists between black and white students. Unfortunately, some teachers, urban educators in particular, hold negative views about the science abilities of African Americans. They assume that the intelligence of their black students is inferior to Asian and Caucasian children (Atwater, 2000). Unfortunately, these educators do not realize that they are devaluing the knowledge that their African American students possess and are lowering their expectations for achievement. Teacher expectations have an impact on the success of students. Children respond to the way their teachers treat them and they produce work accordingly. Educators who do not support their students and the knowledge they possess will have students who contribute less in the science classroom (Atwater, 2000). In Taylor's (2002) work, students complained:

We don't get much support from teachers. They just hand out the work and expect us to do it and learn without doing much teaching. Teachers often did not explain the work well and ran through the material quickly without seeming to care whether students understood. Many teachers handed out work without providing an introduction, checking for prior knowledge, or making sure that students were clear about expectations (p. 74).

Some scholars have suggested that low teacher expectations are a result of the educator's racial demographics. For example, a predominant number of teachers working in urban, predominately black, middle schools are white females (Luft, 1998). Ideally, such a contrast between the educators' racial backgrounds and the students they teach would provide excellent educational opportunities for gaining insight into each other's cultures. However, this learning exchange typically does not occur. Unfortunately, a number of urban educators rarely take the time to learn more about their students, their backgrounds, or their cultures.

Moreover, a number of white female teachers are unable to talk about their own cultures and values because they are often unaware of them (Gay, 2002). This barrier in cultural exchange is further perpetuated because few urban teachers live in the same neighborhoods as their students. They typically reside in suburban areas whereas their students live in urban sections of town (Atwater, 2000). Because most cities are racially and socially segregated, student interactions between different cultures usually only occur at school. For this reason, the encouragement and practice of acknowledging diversity is necessary at school. When multicultural understanding and appreciation is missing from teacher expectations, classroom practices, and school lessons, a breakdown occurs between teacher and student (Norman et al., 2001).

As argued above, educators' views about and expectations for their students contribute to the achievement gap. When black students do not believe that their teachers understand and respect them, they do not perform well in science class (Luft, 1998). As a result, students become disengaged and their science education and learning suffers (Atwater, 2000). In hopes of reducing the achievement gap, educators need to reflect on their expectations for black students and alter their practices accordingly.

Quality of Educators

The last factor that contributes to the achievement gap is teacher quality. Tate (2001) has proposed that teacher quality relates to subject matter and pedagogical knowledge, years of experience, practices, and or certification status. This research has connected how teacher quality influences student opportunities to learn and subsequently affects student achievement. In urban settings, the milieu in which I conducted my study, teacher quality is questionable. Teachers in urban schools are more likely to be under-prepared, to teach content in an area in which they are not certified, and to have fewer years of teaching experience than their suburban colleagues. A deeper look at various teacher qualities provides insight into its impact on student achievement.

Teacher preparation is one quality that affects the black-white achievement gap. A number of urban educators lack proper college preparation and have insufficient knowledge about teaching and learning (Darling-Hammond, 1999). Furthermore, these teachers have limited access to effective in-service sessions or

professional development opportunities. Because of this deficit in teacher preparation, urban educators are unequipped to successfully handle the unique challenges and struggles of urban education and teaching, specifically in regards to minority student achievement.

A second quality of urban educators impacting students is certification. Teachers in urban schools are more likely to lack certification in the subject areas they are teaching. This factor is primarily due to the issue of retention and turnover rates of educators in urban environments (Darling-Hammond, 1999). Because these rates are so high, filling teaching positions is critical and uncertified teachers are often hired. Of course, this approach to selecting teachers for urban schools affects minority success rates. One study of high and low achieving schools has found that differences in teacher qualifications and certification impacted student achievement (Darling-Hammond, 1999). More successful schools typically retained teachers who were certified and received high scores on state and national licensing exams. Consequently, less successful schools, primarily urban, routinely hired educators with low scores on state and national licensing exams or without proper teacher certification (Darling-Hammond, 1999).

A final quality of educators that influences student achievement is experience. Urban school systems have increased instances of novice teachers, educators having less than three years of teaching experience. Darling-Hammond (1999) have identified that inexperienced teachers are observed to be less effective than more seasoned educators. These teachers tend to incorporate the whole-class, teacher-led instructional strategies in their classrooms. As previously mentioned,

these strategies target low-level process skills and are less effective in producing conceptual understanding (Hewson et al., 2001; Tobin et al., 2001).

The aforementioned indicators of poor teacher quality negatively impact the education of students in urban classrooms. These settings are primarily populated by minority students, of which black students are a part. With under-prepared, uncertified, and inexperienced teachers continuing to educate black youth, the gap in achievement will persist. Clearly, teacher quality impacts student achievement.

Teacher Quality and Instructional Representations

Does teacher quality affect the type of instructional representations selected for classroom use? Why is it that some educators use certain instructional representations more often than others? A study by Hashweh (1987) has identified a connection between teacher quality, specifically conceptual understanding, and the use of representations to instruct students. The research found that educators who are less knowledgeable of the subject matter generally limit the representations used to textbook learning. This is especially true of inexperienced teachers, educators who may be teaching out of their field, and those who are not entirely confident with teaching new material (Hashweh, 1987). Compared to instructors with more in-depth understandings of the concepts, novice teachers rarely modified the text instruction or used supplemental activities or representations to explain the ideas (Hashweh, 1987).

The problem with limiting instruction to the use of textbooks is that many of the in-text diagrams are illustrative rather than explanatory (Gobert & Clement,

1999). Illustrative representations simply depict characters while explanatory diagrams clarify the subject matter (Gobert & Clement, 1999). In order for educators to more confidently use a variety of visual displays, illustrative and explanatory, to facilitate student learning and comprehension, teachers first need to become more comfortable with their own science conceptual knowledge (Gobert & Clement, 1999).

The connection between representation use and teacher quality is often observed in high poverty, urban school settings. Because these educators are more likely to be inexperienced, under-prepared, and unsure of effective practices, they typically use the textbook as the primary representation tool (Hewson et al., 2001). This practice leaves little time for interaction between teacher and students, a necessity for academic success. Meehan et al. (2003) have noted that, “ineffective/inefficient classrooms used 40% of the class time with students engaged in whole-class activities and with no time for interaction” (p. 7). Students in this environment often become passive learners and have difficulty mastering the concepts.

On the other hand, experienced teachers are more confident in their subject knowledge and understand the importance in using a variety of methods to represent the science information (Hewson et al., 2001). They know when re-teaching is necessary and use multiple representations to bring about conceptual understanding. Consequently, their students are more successful in learning the information. Experienced educators provide more time for student interaction and engage learning through a variety of individual, student-centered lessons. Meehan et al. (2003) have suggested that when such practices are incorporated about 70% of the time,

classrooms are more effective and efficient. Clearly, it would benefit educators to assess their teaching practices and implement representations to improve student learning. This improvement in teaching will affect the success rates and help reduce the black-white achievement gap.

What other steps can educators take to adequately prepare their students in science and help diminish the achievement gap? For this study, I will focus on assessing African American students' interpretations of lesson objectives with respect to instructional representations used in the science classroom. The study focuses upon the articulation of lesson goals made by sixth grade science students in an urban school.

Overview of Study

In Chapter II, I review the research most relevant to my investigation; more specifically, I synthesize the literature on instructional representations. Chapter III describes the student sample I involved in the study, the methods implemented to collect data, and the processes used to analyze the data. Chapter IV presents the results and findings from this research project. In this section, I present descriptive and visual interpretations of the data. Also included in Chapter IV are the conclusions I generated from the study, implications from the data, and limitations to the research. Finally, Chapter V presents a journal-ready manuscript of the research conducted.

Chapter II

Literature Review

Education is a complex field of study focused on the pedagogy of teaching and learning. It is a profession that uses research to investigate and incorporate best instructional practices, assessment strategies, and management techniques in the classroom. Science education is specifically concerned with seeking to find the optimum teaching methods that assist students with conceptual understanding of the content (Ertepinar & Geban, 1996). Furthermore, science educators attempt to provide students with the necessary tools for success not only in the science classroom, but in future academic and career endeavors. Considering the fact that there is an increased international demand for those learned in science and technology, instruction is also concerned with producing successful and competent scientists.

When preparing for teaching, all educators must take into account a key factor affecting instruction, student diversity. The diversity of a classroom's student body is exemplified in the students' ethnicity, cultural backgrounds, developmental levels, and learning styles. Researchers feel this mixture of students in the classroom influences science instruction. Luft (1998) has asserted that the relationship between student diversity and science instruction impacts students' opportunities to do science, relevancy of science instruction to student' lives, and student achievement outcomes.

Due to the variance in student needs and diversity, specifically in regards to student learning styles, researchers have suggested the use of multiple instructional

representations when teaching science concepts (Wu et al., 2001). Instructional representations are the aids, supplements, and tools educators use to enhance learning. The use of a variety of representations strives to ensure that the diverse needs of the students are met and that instruction for different learning styles is successful. Furthermore, the strategy of using a multitude of representations during science instruction helps to eliminate student boredom, enhance attention, and stimulate the ability to focus. When an educator uses one primary method for teaching, students are more apt to lose focus and attention during instruction. However, when students are engaged in science lessons and learn through the use of different instructional representations, they are better able to acquire, comprehend, recall, and apply science knowledge. In turn, they reach a higher level of conceptual understanding.

Depending on the science concepts, goals for instruction, and students' abilities, an educator may elect to use various tools for instruction. Representations may include, but are not limited, instructional videos, diagrams, models, computer technology, software, concept maps, and inquiry labs. More common and widespread representations frequently used in science instruction include lectures, textbook readings, and worksheets (Hewson et al., 2001). Though there are a number of benefits students receive from the representations of lectures, textbook readings, and worksheets, their repeated use as the primary techniques for instruction may not help students to effectively learn the material.

Traditionally, educators have limited their representation of science phenomena to textbooks (Luft, 1998). This often involved the practice of lecturing,

note taking, and completing worksheets. The downfall of this strategy is that textbook instruction typically promotes learning only on the memorization level. Despite this knowledge, educators find this method of concept delivery to be practical for large group instruction, effective for time and classroom management, and easy to plan and implement (Hewson et al., 2001). Such practices result in didactic teaching and passive learning. Students merely memorize the scientific facts but are not engaged in meaningful learning and knowledge construction. Insights into how students learn have prompted science teachers to realize that the textbook approach may not always be the most effective method for encouraging conceptual understanding.

Because of the current research regarding best instructional practices, science educators are altering their teaching strategies. They are moving toward an inquiry-rich, technology-based method of teaching. Alteration in educators' modes of instruction has ushered science education out of the era of teacher-focused schooling into a new arena centered on student-led instruction and exploratory learning. The result of this practice in science classrooms is a participatory teaching and learning environment where instruction is student-centered and interest-driven, thereby, making science more meaningful to students' lives (Barab, Hay, Barnett, & Keating, 2000a).

With inquiry teaching at the forefront of science education, it leads one to question if this is truly the best method of instruction. How are the students interpreting inquiry practices and other instructional representations? Are they actually learning the science concepts necessary for success or are they merely

experiencing a multitude of teaching practices without comprehending concepts? It is my assertion that a range in student learning occurs when an assortment of practices are employed in the science classroom. A variety of instructional representations help to meet the needs of the students by covering science through a range of learning styles.

A more detailed look at the representations available to science educators will provide further insight into their affect on student learning and conceptual understanding. The focus of this literature review identifies several common instructional representations, their importance to science instruction, and the research signifying their impact on student learning.

Textbook Representations

Naturally, one goal of science instruction is to empower students to recognize and learn concepts and to apply them to their lives (Newton, Newton, Blake, & Brown, 2002). In order to apply concepts to their daily lives, students must acquire explanatory understanding. Explanatory understanding goes beyond mere understanding of science descriptions by seeking out and providing evidence for explanations of science phenomena (Newton et al., 2002).

Science descriptions are a collection of facts and other unconnected pieces of information, whereas science explanations attempt to link these facts and relate them to prior knowledge and experiences. Most textbooks primarily serve as resources composed of science facts and descriptions. One problem with textbooks is that they do not reach the level of explanation. Textbooks seek to help students

comprehend science by introducing the concepts, describing facts, and providing diagrams to achieve understanding (Newton et al., 2002). However, a problem with excessive reliance on textbook use is that learning occurs on the most basic level. Textbooks often do not account for the variance in students' diverse needs, language and reading levels, or prior subject knowledge. When using the textbook as the primary source for science representations, students typically do not internalize, process, or apply the information as successfully as expected.

Additionally, diagrams and pictures within the text are difficult for students to comprehend (Peacock & Weedon, 2002). Gobert and Clement (1999) have maintained that, "Diagrams are often given to students with the assumption that the presence of the diagram alone should facilitate learning" (p. 40). The issue with the dependence on text diagrams is that they often serve to illustrate or depict the concept, not to explain or elaborate on it. Research has shown that students do not know how to effectively use these diagrams, identify their important features, or connect them to the intended learning goals (Gobert & Clement, 1999).

Furthermore, textbook representations rarely portray abstract science concepts in a manner that students can successfully interpret and internally process. For example, chemistry students using textbook information as the primary representation for learning chemical reactions may have difficulty synthesizing and comprehending the material on a higher level. The chemistry students may not be able to determine which type of chemical reaction occurs, why it occurs, and the implications for its occurrence. Through the "textbook method," students typically learn the chemical reactions by memorization without internalizing the concept.

Ideally, continued instruction would be given using 3-D models of the chemical reactions or other visual representations that enable students to more accurately process and interpret the concepts (Gobert & Clement, 1999).

If students understand the chemical reactions then they will be able to generate interpretations, make translations, and mentally manipulate the representations they are provided (Wu et al., 2001). This is typically not the case with the use of textbooks to represent concepts; therefore, it is necessary for educators to incorporate the use of a variety of representations, supplemental to textbooks, which present science concepts and materials. Literature has shown that limiting representations to textbook readings and diagrams may result in memorization of information rather than the construction of meaningful understanding (Newton et al., 2002).

Supplemental Representations

Research has also argued that instructional representations supplemental to the text greatly assist in successful interpretations by the students. Such instructional tools include inquiry labs, out-of-text diagrams and pictures, graphs, concept maps, and three-dimensional models. These representations are used as aids to support the text and are often more effective in explaining and clarifying subject matter rather than using text alone (Gobert & Clement, 1999). Additionally, other mediums for instructional representations such as technology and computer software provide educators with opportunities to represent science concepts through videos, simulations, virtual reality, eLabs, etc.

Computer Software (Technology)

The use of technology in today's world is widespread and its effect is prominent; therefore its use as an instructional tool in the science classroom is extremely important. Technology provides individuals with the opportunity to conduct extensive research through use of the World Wide Web and to communicate more efficiently through E-mail, chat rooms, and message boards. Projections show that 60% of all jobs will require technological skills that only a small portion of American citizens possesses (Mistler-Jackson & Songer, 2000). With such a proliferation of technology, it is imperative that educators prepare their students for the future by incorporating technology into instruction. Not preparing students to utilize technology is setting them up for future failure.

In education, technology in the classroom is steadily increasing. Employment of technology as an instructional tool in the science classroom reflects society in general. The Office of Technology Assessment reports that nearly all, 95%, US schools have one or more computers (Mistler-Jackson & Songer, 2000). This is important because technology provides access to information, resources, and multimedia instructional representations. Additionally, most students routinely access technology and computers at home. By using computers and other technologies as mediums for implementing instructional representations, teachers can connect science to aspects of life familiar to students. For example, technology in the classroom provides educators with a way to adapt instructional representations to more successfully ensure student understanding. Barab, Hay, Squire, Barnett, Schmidt, Karrigan, et al. (2000b) have insisted that:

Current technological advancements make possible new types of learning experiences, moving from transmission models where technology functions like books, films, or broadcasts to environments in which the technology functions like studios and laboratories in which students immerse themselves within interactive contexts that challenge and extend their understandings (p. 10).

Studies have also shown that technology-centered representations are interactive and allow students to manipulate and internalize the information more successfully (Wu et al., 2001). This is evident in a study that utilized eChem, computer software, to represent chemical relationships. Participants worked with eChem to assign meanings to novel representations by making visual connections between 2-D and 3-D models. With the application of technology, student understanding improved greatly when compared to their textbook learning. The use of technology allowed the students to manipulate the information and to make it more meaningful to their individual learning (Wu et al., 2001).

The incorporation of technology also adds to the practice of differentiating science instruction. Teachers are able to use technology to meet students at their point of understanding and push them toward success in science. At school, students can access information on the computer, download it for use at home, and modify it to suit their needs (Skinner & Preece, 2003). This practice of modifying information shows how students are able to utilize technology to personalize science learning. In the science classroom, students can integrate technology and take an active part in learning by accessing the Internet, playing science-related games, completing projects, and using instructional programs.

In addition, students can use technology to further improve word-processing skills, develop spreadsheets and graphs, and familiarize themselves with software programs. These are all skills necessary for success in most career fields (Mistler-Jackson & Songer, 2000). In order to explicitly make connections among science facts, children can also use such programs as Inspiration™ to create computer-based concept maps or Apple Works™ to draw, paint, and manipulate images as a way to make science learning more meaningful. As well, utilization of computer virtual reality programs can help children to learn science concepts through simulated experiences. Such technology-oriented activities stimulate students' multi-sensory organs and encourage their motivation, participation, and interest in learning science (Shim et al., 2003).

Another important use of technology in the classroom is that it allows students to have access to current science information and research around the world. Daily, students have the opportunity to view satellite images and real-time videos to enhance instruction (Mistler-Jackson & Songer, 2000). This is contrary to the use of textbooks, which have fixed information and are only replaced after a number of years of use. Also, students are able to use computers to communicate with professional scientists, universities, and corporations. This cross-community exchange of ideas is effective because science educators are often unable to provide guest speakers for face-to-face presentations in their on-site classrooms.

Technology and the Internet provide students with motivational learning opportunities and increase their science knowledge. Educators must use a variety of instructional methods, including technology, to more thoroughly present the concepts

and meet students' needs. The use of different visual representations helps students to comprehend the information and organize their own mental models of the science concepts (Gobert & Clement, 1999).

Inquiry Labs

The effective use of a variety of instructional representations should not be limited to the use of technology. Science educators should also incorporate inquiry labs into their repertoire of strategies to achieve instructional goals. Berg, Bergendahl, Lundberg, and Tibell, (2003) have acknowledged that, "General goals in education are to promote problem-solving skills, independent thinking, critical thinking, willingness to explore new ideas, and the development of a creative mind" (p. 351). Such goals are often attained through the effective use of inquiry labs as an instructional representation. Laboratory work has been regarded as a necessary and integral aspect of science education (Dechsri, Jones, & Heikkinen, 1997; Ertepinar & Geban, 1996). It is an important tool used to teach students about the process of science, not just the product. Because of its affect on student thought and conceptual understanding, many advocates of inquiry-based instruction have challenged science educators to transition from large-class lectures to hands on student involvement in scientific inquiry (Barab et al., 2000b). This is also a focus of the constructivist paradigm for instruction. In brief, constructivism is a philosophical underpinning of the National Science Education Standards that outline a national vision for science education in the United States (National Research Council, 1996). According to one form of constructivism, students' science thought and understanding is not only

influenced by the context of the lab activities but also by the social nature of interactions with other students (Shepardson, 1997).

Student participation in inquiry labs helps them to construct meaningful knowledge, exchange personal ideas, and think collectively to reach a consensus (She, 1999). Such constructivist practices encourage students to actively discover science and create their own knowledge rather than passively receive it through lectures or confirmation labs. Confirmation or “cookbook” labs limit knowledge construction because they supply students with the lab question and guide them through the steps for answering it, thereby confirming what is already known. This is contrary to the goal of inquiry labs that challenge students to develop their own problem and methods for discovering the information. Therefore, inquiry labs allow students to better understand the nature of science not only as a product, but also as a process.

Studies have also shown that students participating in open-inquiry laboratory experiences are more likely to develop their scientific thinking and process skills (Shepardson, 1997). Inquiry laboratory experiences require students to use prior science knowledge to analyze and interpret data. These labs are highly effective in promoting conceptual understanding and student thought about experimentation, collaboration, data collection, and data sharing (Dechsri et al., 1997). The thinking required in experimentation, data collection, collaboration, and data sharing results in a higher level of learning than the low level recall commonly resulting from textbook use.

Instructional Videos

A final representation used in science classrooms is instructional videotapes. This method of concept delivery provides a visual representation of science concepts; videotapes often apply the concept of interest to real-life experiences. Kumar & Bristor (1999) have reinforced this assertion through the statement that:

The use of video and audio-rich technology enables the presentation of learning environments embedded with information in a real world context. The electronic links between various modes of information representation help the formation of meaningful links between existing knowledge and new knowledge, and facilitate the exploration of new information in multiple perspectives. Often, video-based hypermedia/multi-media technologies provide students an anchor for learning (p. 43).

In addition, instructional videos used in the classroom better explore science concepts through visual contexts that allow for pattern recognition and formation of mental models. Studies have revealed that students who receive a combination of text learning and visual animation through instructional videos have superior performance to those learning through textbooks alone (Michas & Berry, 2000). Also evident in the research is that the realistic displays of science concepts gained from viewing instructional videos is often more beneficial than those attained through pictorial displays found in textbooks.

For instructional purposes, documentaries such as "Nature", science fiction, science instructional programs, and TV cartoons with implied science concepts are utilized (Kumar & Bristor, 1999). Videotapes from such television series as "Bill Nye the Science Guy", "Reading Rainbow", and the "Magic School

Bus” are effective in illustrating science concepts, promoting the understanding of the world around us, and showing student involvement in science (Kumar & Bristor, 1999). These videos can easily be used in the classroom to introduce science concepts or to reinforce student learning. Video creators make it easy for educators to incorporate them in the classroom because segments are typically concept specific. Furthermore, instructional materials, question sheets, and books often accompany the videotapes (e.g., “Magic School Bus”).

For a more realistic and personal learning experience, science educators can have students develop their own videos. By creating their own instructional tapes, students will have an additional opportunity to utilize and reinforce their science knowledge. Videotaping challenges students to creatively display their understanding and to articulate knowledge of science so that it is understandable by those viewing their tape. In science classrooms, students will also benefit from making videotapes because educators can integrate learning from other subject areas including technology, language arts, visual arts, and social studies. Students would not only be responsible for displaying science knowledge, but also for developing scripts and scenery (Kumar & Bristor, 1999). Additionally, educators can implement videotaping in the science classroom as a form of assessment of students’ conceptual understanding. Children can be required to perform hands-on tasks, provide observations, conduct experiments, and display portfolios.

Implications for Science Instruction

As one way to provide students with a well-rounded and varied image of science and learning, the use of different instructional representations is promoted in the science classroom. Using multiple instructional representations will lessen the monotony often associated with science learning. Furthermore, by addressing their different needs, abilities, interests, and learning styles, using a variety of instructional tools will help students to more successfully learn science and build understanding. Additionally, the use of a multitude of instructional representations will help to promote students' interest in and respect for science learning. Finally, variety in the use of instructional representations will push educators to think about their goals for instruction and if the use of certain representations are more beneficial than others. Research is continually being conducted to identify if certain instructional representations should take precedent over others when teaching science (Roth, 2001). In sum, I contend that educators should actively utilize representations from a variety of instructional sources to teach science. In Chapter III, I describe how I used several instructional representations to teach science concepts.

Chapter III

Methodology

After studying the achievement gap that exists between African American and Caucasian children, analyzing the factors contributing to this problem, and reviewing the literature on instructional representations, I elected to narrow the focus of my study to the interpretations made by African American students. Because of my personal experiences as an African American student and educator, I wanted to gain insight into how my black students interpreted lesson goals with respect to the instructional methods I used to present science concepts. I then used the information I obtained from the literature review on instructional representations to generate hypotheses for the research questions I posed in Chapter I.

Research Questions and Hypotheses

Research Question One: With regard to lesson goals, how closely do the African American students' interpretations align with the instructor's intended objectives?

Hypothesis One: African American students will more successfully interpret information from lessons using inquiry labs, Microsoft Works™ (computer technology), or instructional videos. Their comments for these lessons will align more closely with the identified objectives. Students will less successfully interpret information from lessons using textbooks. Their responses made for the textbook lesson will not align with the intended goals.

Literature has shown that the experiences students have with textbooks that promote passive learning and memorization are contrary to exposures they have with

visual and hands-on instructional representations (Hewson et al., 2001; Roth, 2001). Literature has also revealed that these hands-on representations are more engaging and motivating for African American students (Wu et al., 2001; Michas & Berry, 2000; Kumar & Bristor, 1999). Such visual and interactive representations include but are not limited to the following: out of text diagrams and pictures, computer software, inquiry laboratory activities, and instructional videos.

Research Question Two: Does this alignment in interpretation vary with the instructional representations employed by the instructor?

Hypothesis Two: Each of the four different instructional representations will elicit a range in student interpretations of the lesson goals. The alignment of the students' interpretations with the lesson's objectives will also vary. This is based on the understanding of the natural differences that exist between students. Because literature has identified that students have ranges in their ability levels, learning styles, and needs, I assert that I will also find differences in their interpretations and their alignment with lesson goals (Tate, 2001; Atwater, 2000; Luft, 1998). The remainder of this chapter outlines the design of the research, describes the site of the study and the student participants, and details the collection and analyses of data.

Design of Research

I designed the study as an action research project. I selected this methodology for two reasons. First, I would be intricately involved in working with the study's participants by employing the instructional representations I intended to research. Second, I anticipated using the findings to inform my own practice.

Previous literature on action-research provided me with further information about the nature of qualitative studies and the effective utilization of such practices in science education. I first explored information that defined action research and identified the processes involved in implementing it in the classroom. In the literature, Roberts & Dick (2003) have stated that, “Action research is an intervention methodology using action and research to increase understanding of the research situation and at the same time to pursue change” (p. 468). Tabachnick & Zeichner (1999) have described action research as, “A form of collaborative self-reflective inquiry undertaken by teachers to improve their own practices, their understandings of those practices, and the situations in which those practices are carried out. It views teaching as a form of research” (p. 310). These characteristics of action research are further described in Larson, Mayer, Knight, & Golson’s (1998) findings which signified how action research can provide the instructors with practical information they are able to evaluate and incorporate into future instruction; thus, educators are able to “generate educational knowledge as they are conducting their research projects” (p. 7).

Secondly, action research as a method of data collection allows teachers to be an integral part of the research process and to be guided by the data rather than the procedures. Doing so, the practice of using action research helps educators to grow through professional development by investigating the teaching and learning in their classrooms (Briscoe & Wells, 2002). This enables educators to learn from their experiences and extend their research when necessary. Validation for incorporating action research into the classroom was described in a study of a professional

development program (Larson et al., 1998). Educators volunteering for the program were encouraged to develop their own research questions that would increase their personal awareness of classroom instruction and would enable them to better analyze their students' learning. Participants listed the following comments to show the beneficial aspects of their experiences with action research:

- Applying science strategies for study about student learning and achievement; the sharing of information and ideas.
- I learned to question my techniques, carefully watch them over a period of time and make changes. The program gave me the tools to assess my techniques.
- Using the classroom as a basis for research; discovery that students' perceptions are very different from teachers'.
- I found the experience valuable. Teachers are researchers. My findings were interesting to me as a teacher (p. 8).

Finally, I agree with other researchers who have attested that action-research helps to narrow the research-practice gap. By doing so, first-hand research allows data to be easily accessible to the educator, immediately helping to improve classroom instruction. Teachers conducting action research become more in-tune with their teaching practices and gain insight into how their students think, reason, and learn science. In Briscoe & Wells' (2002) study, teachers explained the positive effects action research projects had on their classroom practices, effects they may not have experienced if they were not the primary researchers. Teachers reported that:

- they have become more aware of effective instructional practices
- they have expanded their commitment of developing a variety of teaching methods and a renewed desire to stay current
- they have a renewed interest in learning about teaching
- they have increased understanding and awareness of self (p.418).

Such comments describe the benefits of bridging the gap between research and practice by implementing action research in the classroom.

Site of Study

I conducted my study during the spring semester of the 2003-2004 school year. The research took place in a sixth grade science classroom at a middle school located in Wake County, North Carolina. This middle school follows the traditional school system calendar for educating students and serves children from grade six through grade eight. Students following the traditional educational calendar progress through nine months of in-school instruction with two and a half months for summer vacation before matriculating to the subsequent grade level (Wake County Public, 2002-2003).

The sixth grade students included in this study were instructed in my science classroom. The flexible design of this research site allowed for both lecture and laboratory teaching. I arranged the students' tables to promote a classroom environment supportive of constructivist practices (Spaid, 2001; National Research Council, 1996). The seating was arranged in six distinct groups for cooperative learning between four to six students. Each group was centered on a common lab

area and computer workstation that further encouraged an environment for collaborative learning. Also, the layout of the classroom supported large group work and discussion.

Population of Students at the Middle School

The demographics for the student population at this school represent a heterogeneous mixture of individuals from various racial, ethnic, and ability groups. Table 3 reflects the racial/ethnic distribution of the student population at this school during the 2002-2003 school year (Wake County Public Schools, 2002).

Table 3
Fall 2002-2003 Student Population Characteristics

	White	Black	Asian	Hisp	Mult	AmIn
Grade 6	188	86	18	37	7	2
Grade 7	203	87	17	31	13	2
Grade 8	210	24	16	37	11	1

Hisp = Hispanic, Mult = Multiracial, AmIn = American Indian.

One measure of student achievement in the Wake County Public School System is the End of Grade (EOG) Exam. EOG tests are administered for all students in grades 3 through 8. Students' scores on the EOG are reflected in percentages. To verify the historical achievement gap between African American and Caucasian students at this school, I located statistics of the students' EOG scores for reading and mathematics during the 2001-2003 testing years. Students selecting the appropriate

box for race on the EOG answer sheet provided the distinctions between African American and Caucasian children. EOG information for Caucasian and African American students' reading scores in 2003 is supplied in Table 4. Table 5 identifies students' EOG scores for mathematics. Graphical representations of the 2003 data are found in Figures 1 and 2. Graphs for 2001 and 2002 EOG scores are found in Appendixes A through D.

The information revealed in Tables 4 and 5 and Figures 1 and 2 illustrates a history of a gap in the EOG scores; these scores are used as indicators of achievement. When the scores are viewed, an achievement gap between the African American and Caucasian students that attend this middle school is evident. EOG scores for the sample population were not available at the time of this study.

Table 4
2003 Reading Percentages of Students Scoring At or Above Grade Level By Race

Grade	White			Black		
	2001	2002	2003	2001	2002	2003
6	90	92	90	49	55	69
7	94	93	96	58	62	75
8	94	98	98	69	70	76

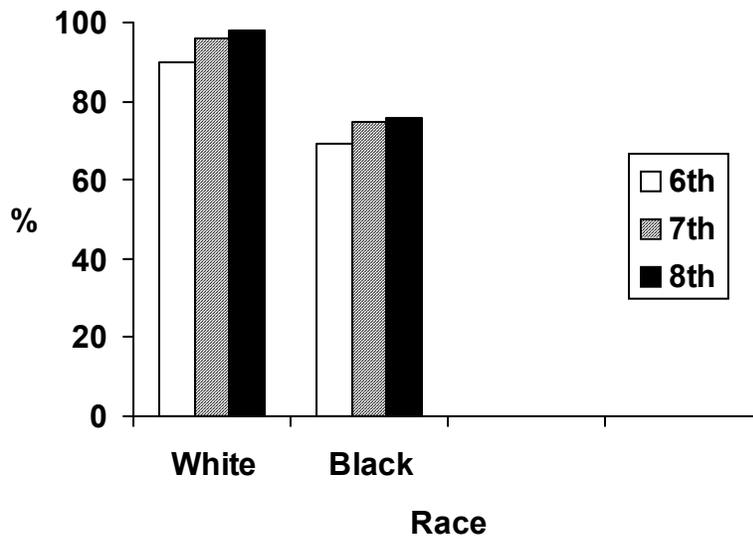


Figure 1. 2003 Reading Percentages of Students Scoring At or Above Grade Level By Race.

Table 5
2003 Mathematics Percentages of Students Scoring At or Above Grade Level By Race

Grade	White			Black		
	2001	2002	2003	2001	2002	2003
6	96	98	93	65	75	77
7	97	97	98	61	69	74
8	97	95	98	74	73	69

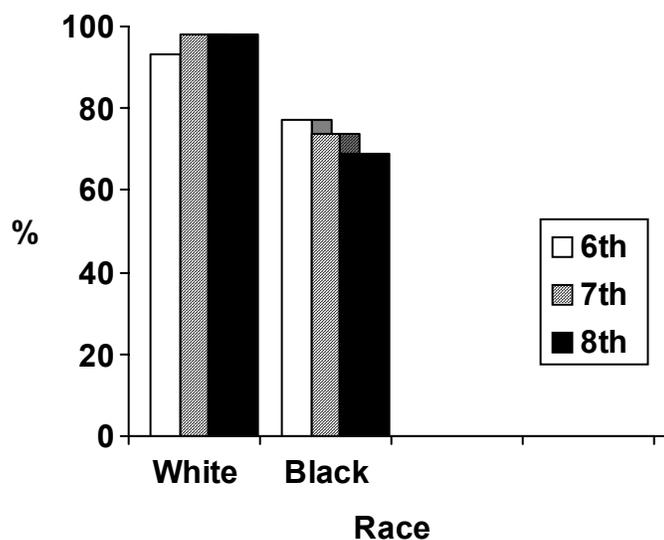


Figure 2. 2003 Mathematics Percentages of Students Scoring At or Above Grade Level By Race.

Sample of Students

Students at this middle school are grouped on academic teams consisting of teachers from each of the core subject areas of mathematics, language arts, social studies, and science. I was the science teacher for 128 students. The 128 students made up five separate classes that met for 50-minutes a day. From the total population of science students (128 students) on the selected sixth grade team, 38 (30% of the total population of science students) African American students participated in the study. I selected the African American children as research participants on the basis of convenience. Table 6 shows the number of students in each of the five science class periods observed. The number of African American students in each class period is also reflected in the table.

Table 6
Number of Students in Five Class Periods

Class	Total	African American
1	24	7
2	26	6
3	30	6
5	24	8
6	19	11

In regards to classroom instruction, I followed the North Carolina Standard Course of Study for sixth grade science when teaching all of the students in the team population, including the research sample. I used a variety of instructional representations to teach the science concepts. During the spring semester, students received instruction for the following science topics:

- history of the space program and space exploration
- the solar system, including the nine planets, the sun, and other space objects
- scientists and astronauts impacting the study of space
- energy transfer and heat
- inquiry and science process skills

During the study, all of the students in the research population were exposed to the following representations: the sixth grade science textbook, Microsoft Works™ (computer technology), inquiry labs, and science instructional videos. I selected four lessons for data collection. These four lessons were selected because

they characterized instructional representations commonly used in my classroom. Additionally, each of the lessons used one of the previously mentioned instructional tools. The lessons and representations I selected for data collection are displayed in Table 7. A description of each lesson is also provided.

Table 7
Science Lesson and Instructional Representation Used

Lesson	I.R.
Constellation Brochure Project	Microsoft Works™
“Bill Nye the Science Guy” Heat & Energy	Instructional Video
Heat & Energy Vocabulary Building	Science Textbook
Temperature Lab	Inquiry Lab

I.R. = Instructional representation.

Descriptions of Lessons

I called the first lesson the “constellation brochure project.” The lesson lasted for five fifty-minute class sessions and used technology as the instructional representation. More specifically, the students used the Microsoft Works™ computer program. During this lesson, students randomly selected the name of a constellation from a cup. They then conducted research on the constellation that was selected. Research facts were first gathered from the textbook and related science books. The students then collected information from school-approved websites on the Internet. Data that was gathered about the constellations was recorded on research sheets provided by the instructor. After finding facts, the students designed an

informational brochure for their constellations. The brochures were created on the computer using the Microsoft Works™ program. When all of the students completed their brochures, they presented the finished product and constellation information to the class.

Lesson two, the lesson on heat, lasted for one fifty-minute class session. The representation I used for the lesson was an instructional video. As an introduction to the new unit on energy transfer, the students viewed a video from the “Bill Nye the Science Guy” collection. It focused on the concepts of heat and energy. In viewing the video, students observed examples that pertained to the topics. Furthermore, they were introduced to vocabulary words. The information in the video was delivered through demonstrations conducted by Bill Nye, real-life examples, and music.

The third lesson lasted for one fifty-minute class session. This lesson focused on energy transfer and vocabulary building by using the science textbook as the instructional representation. To reinforce the concepts of heat and energy learned in the previous lesson, students completed a vocabulary building assignment. This lesson required the students to use their textbooks to define vocabulary words. The students were also required to connect these words to the concepts of heat and energy through various activities including word unscrambling and concept mapping. Vocabulary skills such as correctly spelling, pronouncing, and alphabetically ordering words were also involved in completing this assignment.

The final lesson on energy transfer lasted for two fifty-minute class sessions. This lesson incorporated an inquiry lab as the instructional representation

for teaching these concepts. For this lesson, students were given a question: Does temperature affect the diffusion of food coloring in water? With a partner, students were required to design and conduct an experiment to answer this question. Groups were asked to describe their hypothesis, materials needed, procedures, and problems encountered. They were also required to collect data and graph their results. Because the groups' experimental designs differed, the information they obtained from the lab varied. Students were then challenged to answer questions about the lab. Finally, each pair of students presented their findings to the class.

Collection of Data

Prior to implementing the instructional representations, I completed information on a teacher objective sheet. I provided the date, science topic, and instructional goals for the lesson. A separate objective sheet was completed for each of the four lessons and instructional representations applied. An example of the teacher objective sheet for the textbook instructional representation is provided in Appendix E.

After completing each teacher objective sheet, I taught the corresponding science lesson. The lessons exposed students to the science content as well as the selected instructional representation. During the next class session that followed the lesson and representation, I distributed student feedback sheets. A separate feedback sheet was used for each of the four instructional representations implemented in class. On the feedback sheet, I asked the students to respond to the following

question: What was today's science lesson about? The reason for asking this question was to elicit the students' understanding of the lesson's objectives.

I used the students' articulation of the lesson's goals to make inferences about their interpretations of the lesson. From the extent to which the students' articulation of the lesson's purpose matched the objectives I recorded prior to teaching the lesson, I deduced the effectiveness of the instructional representation used to teach the concept. On the feedback sheets, students in my science classes were encouraged to respond to the best of their abilities. They were asked not to put their names on their sheets and were made aware that their responses would not be graded or counted against them. Appendix F provides an example of a student feedback sheet.

Analysis of Data

For each instructional representation used, the documented lesson objectives were compared to the responses on the corresponding student feedback sheet for that lesson. To do this, I first identified keywords from each lesson on the instructor's objective sheet. I chose the keywords that best reflected the goals and were likely to be mentioned by the students. These keywords were used to code students' comments on their response sheets. Tables 8 through 11 document each lesson's goals and the keywords I identified.

Table 8
Keywords Used to Identify Students' Interpretations of Lesson Goals for the Lesson Using Computer Technology

Instructional Goals	Keywords
The students will research randomly selected constellations using books and the Internet.	Research, Search, Internet
The students will learn about constellations (groups of stars).	Constellations, Stars
The students will learn information about constellations, including: mythology (story), location, time of year, stars, etc.	Mythology, Story Information
The students will use the computer to create informational brochures for their constellations.	Brochure, Computer

Table 9
Keywords Used to Identify Students' Interpretations of Lesson Goals for the Lesson Using Instructional Video

Instructional Goals	Keywords
The students will view the “Bill Nye the Science Guy” video to begin learning about the concepts of energy and heat.	Heat, Hot & Cold Cool & Warm
The students will begin to understand that energy is transferred through three methods: conduction, convection, and radiation.	Energy
The students will begin to understand that energy is transferred through three methods: conduction, convection, and radiation.	Conduction, Radiation Convection

Table 10
Keywords Used to Identify Students' Interpretations of Lesson Goals for the Lesson Using Textbooks

Instructional Goals	Keywords
The students will learn new vocabulary words and their definitions.	Vocabulary, Words, Definitions, Meanings
The students will learn how these vocabulary words are related to the concepts of energy and heat.	Energy, Heat
The students will complete activities to increase their vocabulary building skills. (i.e. word unscramble, ABC order, concept maps).	ABC order, Word Unscramble, Concept Maps

Table 11
Keywords Used to Identify Students' Interpretations of Lesson Goals for the Lesson Using Inquiry Labs

Instructional Goals	Keywords
The students will design a lab experiment.	Lab, Experiment, Project
The students will learn more about energy and temperature.	Energy, Temperature, Heat, Hot & Cold,
The students will observe how temperature affects the movement (diffusion) of molecules in water.	Movement, Spread, Dissolve, Melting, Molecules, Diffusion, Turning
The students will work in groups to complete the lab.	Groups, Partners, Teams

After identifying the keywords, I analyzed the students’ responses on the feedback sheets and highlighted comments that included the keywords. Based upon the number of keywords identified (i.e., zero, one, two, etc.), I divided the student response sheets into categories. Finally, I calculated the percentage of the keywords the students mentioned in their responses. Percentages were used because the number of goals for the lessons varied. Percentages were calculated using the following equation:

$$\frac{\text{Number of Keywords Identified}}{\text{Total Number of Keywords for the Lesson}}$$

I used the percentages to determine the extent to which the African American students identified the objectives of the lesson. I labeled the extent “degrees of articulation.” Descriptions of the degrees of articulation are provided in Table 12.

Table 12
Degrees of Articulation

% Interpreted	Degree of Articulation	Description
0	Unsuccessful	Articulated no information
25-50	Inadequate	Articulated little information
66-75	Adequate	Articulated the majority of the information
100	Successful	Articulated all of the information

In summary, the data I gathered helped me to answer the research questions that guided this study. In order to answer question one, “With regard to lesson goals, how closely do the African American students’ interpretations align with the instructor’s intended objectives?” I analyzed the students’ responses on their feedback sheets. The intent of this analysis was to determine to what extent the black students articulated the purpose of the science lessons. To answer question two, “Does this alignment in interpretation vary with the instructional representations employed by the instructor?” The students’ responses, the degrees of articulation and the corresponding percentages, and what I inferred from the percentages comprise the findings. The findings are discussed in Chapter IV.

Chapter IV

Results and Conclusion

Analysis of the African American students' responses on the feedback sheets provided useful information for answering my research questions. The process of comparing my lesson objectives to the students' comments resulted in what I called degrees of articulation. The students' remarks provided insight into how they interpreted the objectives of the lesson via instructional representations used to teach the science concepts. I present the results of the study in this chapter. Results for lessons one, two, three, and four are represented in Tables 13 through 16 respectively. To further illustrate the degrees of articulation, I give examples of the students' responses for each lesson. Words the students mentioned that aligned with the instructor's goals are underlined. Refer to tables 8, 9, 10, and 11 that display the keywords that surmised the instructor's goals for each lesson.

The findings for lesson one are summarized in Table 13. Information presented in this table shows that the majority of students' responses in lesson one were inadequate. Their comments denote that students were only able to articulate responses aligning with 25 to 50% of the lesson goals. Though a look at their comments reveals that a large portion of the students was able to successfully derive that the lesson involved the study of constellations, few were able to state additional objectives. Lesson one data indicate that a significant number of the African American students inadequately interpreted the objectives of the lesson that used the Microsoft Works™ program (technology) as an instructional representation to teach the concepts. These findings are contrary to my first hypothesis and the research

advocating the effectiveness of computer technology as a tool for instruction (Shim et al., 2003; Skinner & Preece, 2003; Roth, 2001; Wu et al., 2001; Barab et al., 2000b; Mistler-Jackson & Songer, 2000; Gobert & Clement, 1999).

Table 13
Results for Lesson One (I.R. Microsoft Works™ Computer Technology)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	3	Learning. This project is about space. Because we are talking about it. It is very fun.
Inadequate	23	We used books and the <u>computer</u> for this project. We had to find main ideas. It was about the <u>constellations</u> . Your constellations can be in a month. It showed patterns of the stars. <u>Myths</u> .
Adequate	2	We went to the <u>computer</u> lab to use the computers so that we could use the <u>Internet</u> and learn about the <u>constellation</u> that we picked from the jar.

Table 13 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
		This week's lesson is about <u>constellations</u> . We learned how the constellation was named, look, and who it was <u>named after</u> , etc. The <u>brochure</u> was to help us learn more about the constellation we had.
Successful	3	<p>The <u>brochure</u> project was a little exciting. We went on the <u>Internet</u> to <u>search</u> and to learn about Taurus and our <u>constellation</u>. I love the way we do our brochures but I can't figure out the <u>computer</u>. It was still a little hard.</p> <p>Last week lesson was about the <u>brochure</u> that we had to do on our <u>constellation</u> that we had chose. And we went to the <u>computer</u> lab and did <u>research</u>.</p>

* 36 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Data for lesson two is displayed in Table 14. Unlike results found in lesson one, information for lesson two explains that the majority of students' responses demonstrate an adequate degree of articulation. From the comparison between the students' responses and my instructional goals, I inferred that sixteen students were able to interpret objectives that aligned with 66-75% of the intended goals for lesson two. In their comments, the students mention brownies, pancakes, popcorn, and ice statues; students encounter many of these items in their daily lives. These responses are consistent with my first hypothesis. They indicate that the students interpreted information from the instructional video that was couched in real-life contexts, thereby supporting the importance of relevancy in science learning advocated in the literature (Roth, 2001; Michas & Berry, 2000; Kumar & Bristor, 1999).

Table 14
Results for Lesson Two (I.R. Instructional Video)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	3	How to bake brownies and pancakes and how to build an igloo. I think it was funny and helpful, amazing, crazy, learn.
Inadequate	8	It was about <u>heat</u> and what causes heat. Also, what makes up heat.

Table 14 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
Adequate	16	<u>Energy</u> and <u>Heat</u> . <u>Heat</u> and how it moves and how it came to be. <u>Energy</u> of how it moves and goes on.
Successful	5	It was about <u>radiation</u> , <u>convection</u> , <u>conduction</u> and <u>heat</u> for example, <u>energy</u> transfer and power on a stove and how popcorn pops. It was about <u>heat</u> , <u>energy</u> . Learned about the 3 types of heat (<u>conduction</u> , <u>convection</u> , and <u>radiation</u>).

* 32 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

The results for lesson three are displayed in Table 15. I was not surprised by the data I found. In my first hypothesis, I stated that I expected to discover a larger portion of students having an unsuccessful interpretation of lessons using textbooks. This statement was consistent with the findings in that 23 students

inadequately stated goals for the lesson that utilized the textbook instructional representation. The classification of their comments as inadequate denotes that the students' comments only aligned with 25 to 50% of the lesson objectives. For lesson three, a number of students identified the general object of the lesson; they stated that the lesson involved the study of vocabulary and the concepts of heat and energy, but they were unable to mention other goals.

Table 15
Results for Lesson Three (I.R. Science Textbook)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	7	<p>Today's lesson is about how to stay cool. How running makes you warm.</p> <p>To learn the things we don't know and to review for the things we know.</p>
Inadequate	23	<p>It was about learning important <u>words</u>.</p> <p>Yesterday lesson was about all types of <u>energy</u> and how energy is formed into light, heat, and other things.</p>
Adequate	3	<p>It was about the types of <u>heat</u> and <u>energy</u>, also about <u>vocab</u>.</p>

Table 15 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
		It was about <u>vocab</u> for our new unit <u>Heat and Energy</u> .
Successful	2	To learn the <u>words</u> of <u>energy</u> and <u>heat</u> and what they <u>mean</u> and how they work and are <u>connected</u> . We did <u>vocabulary</u> about <u>heat</u> and <u>energy</u> . We also did a <u>diagram</u> on heat and energy. We did <u>ABC order</u> and <u>heat/energy unscramble</u> .

* 34 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Table 16 identifies data for lesson four. As in the cases of lessons one and three, the results for lesson four show that the majority of the students' interpretations reveal an inadequate degree of articulation of the lesson objectives. These findings do not correspond with my expectations. The twenty inadequate comments show that students only articulated information aligning with 25 to 50% of the lesson goals. The category showing the second largest number of responses was the adequate degree of articulation; this finding is more consistent with my expectations for lesson

four. Eleven students were able to adequately state 66 to 75% of the objectives. For this lesson, most of the students' responses mentioned that the lesson involved a lab or experiment and was focused on the concepts of heat and energy.

Table 16
Results for Lesson Four (I.R. Inquiry Lab)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	2	Fun class.
Inadequate	20	We presented our <u>labs</u> . To learn about <u>heat and energy</u> .
Adequate	11	I think this science <u>experiment</u> was about <u>energy and heat</u> also the <u>temperature</u> was important. It was about how <u>heat</u> affects other <u>molecules</u> like food coloring.
Successful	2	Today's science lesson was mainly about the <u>temperature</u> of liquid. On my <u>experiment</u> , I learned that food coloring <u>moves</u> faster in hot water than in cold water.

Table 16 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
		We did an <u>experiment</u> on seeing how fast <u>warm, cold, and hot temperatures</u> of water <u>move</u> when you put food coloring in it.

* 35 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Discussion

Through my work, I recognized that the sample of African American students did derive a variety of elements related to the lessons but what they gained was often not what I intended. The students' responses portrayed four distinct degrees of articulation of lesson goals: unsuccessful, inadequate, adequate, and successful. Students who were unable to identify any or a small percentage of the keywords were classified as having unsuccessful and inadequate degrees of articulation, respectively. Their comments showed that their derivations of the objectives were drastically different from the intended goals. Therefore, I determined that these students were unsuccessful in their interpretations of the lesson. Conversely, students who mentioned the majority or all of the keywords showed adequate and successful degrees of articulation, respectively. These students'

responses aligned closely with the instructor’s goals; I inferred that this group of students successfully interpreted the lesson.

For question one: With regard to lesson goals, how closely do the African American students’ interpretations align with the instructor’s intended objectives? I identified the information African American students derived from four lessons through the analyses of their responses and the development of the classification system labeled “degrees of articulation”. Table 17 displays the combined results for all four lessons. Data illustrated in this table convey that the majority of the total responses made by the African American students showed an inadequate degree of articulation of lesson goals. Seventy-four of the students made comments that only aligned with 25 to 50% of the instructor’s intended objectives.

Table 17
Combined Results for all Lessons

Degree of Articulation	Total # of Responses
Unsuccessful	12
Inadequate	74
Adequate	11
Successful	12

Patterns in data emerged that provided answers for research question two: Does this alignment in interpretation vary with the instructional representations employed by the instructor? Information in Table 18 shows the combined percentage of student responses for each instructional representation. From these

numbers, I noticed that the largest percentage of unsuccessful comments was made in response to the textbook lesson. Also, percentages observed in Table 18 identify that the greatest number of successful comments was given in response to the lesson using the instructional video. My findings revealed that the instructional representation used might affect the extent to which students' responses align with lesson objectives.

Table 18
Combined Percentages of Responses for the Four Instructional Representations

I.R.	Responses	
	Unsuccessful	Successful
Computer Technology	8	8
Instructional Video	9	16
Science Textbook	21	8
Inquiry Lab	6	6

Evaluation of Hypotheses

Though a look at student responses in lesson one (refer to Table 13) showed that a large portion of the students was able to successfully articulate that the lesson involved the study of constellations, few were able to state additional objectives. These data indicated that a significant number of the African American students inadequately interpreted the objectives of the lesson that used the Microsoft Works™ program (technology) as an instructional representation to teach the concepts. My

findings for lessons one and four are contrary to my first hypothesis and the literature that asserts that students will find greater levels of achievement with lessons incorporating technology and inquiry labs (Berg et al., 2003; Shim et al., 2003; Skinner & Preece, 2003; Roth, 2001; Wu et al., 2001; Barab et al., 2000b; Mistler-Jackson & Songer, 2000; Gobert & Clement, 1999; She, 1999; Dechsri et al., 1997; Shepardson, 1997).

For lesson two (refer to Table 14), a number of students were able to successfully interpret the objectives for the lesson using the instructional video. I believe that if students are able to articulate the purpose of the lesson then they are more likely to learn what was intended. These findings are consistent with my first hypothesis and the literature that encourages the use of instructional videos to promote an increase in student learning (Roth, 2001; Michas & Berry, 2000; Kumar & Bristol, 1999).

As illustrated in the students' comments shown in Tables 13 through 16, the second hypothesis was confirmed showing variability within African American students' responses. These findings are supported by literature that identifies students as having different abilities and learning styles (Tate, 2001; Atwater, 2000; Luft, 1998). Because of these differences in students' needs, I expected the ranges in responses I found.

Implications

I believe that this study provides a number of valuable implications for the field of education. These implications pertain mostly to classroom teachers and their

students. One major implication resulting from this study shows how action research can be implemented during classroom instruction. Action research is important because it connects practice and research and gives teachers context-specific information to help inform and improve their teaching. Utilization of this method of research provides educators with insightful information about what their students articulate from science lessons (Larson et al., 1998). Furthermore, it supplies teachers with the opportunity to analyze their teaching practices and the impact they have on student learning (Briscoe & Wells, 2002). Ultimately, data gathered from action research can help to improve instructional strategies of teachers and conceptual understanding for their students.

The results from my study will greatly impact my future teaching. The patterns that emerged from students' responses showed me that my goals for instruction were interpreted to different degrees. Because of this, I will strive to clearly communicate the lesson objectives to the students and make sure that they understand my purpose for using different instructional tools to teach concepts. The lesson using an instructional video as a representation for heat and energy generated the largest number of comments showing a successful degree of articulation and alignment with lesson goals. This finding shows that videos are an effective instructional representation for introducing science concepts to African American students. Data also reveal that textbooks as an instructional representation for heat and energy generated the most responses showing an unsuccessful degree of articulation and alignment with lesson goals. From this information, I acknowledge

that in future teaching practices I will limit textbook instruction and will increase my use of videos.

Limitations

Scope of Study

The significance of this study is not limited to the implications for practice, but it is also necessary for highlighting various issues that emerge in action research. The research implications largely stem from the study's limitations: restricted focus, analysis of the students' responses, teacher-researcher bias, sample size, student mortality, and blank feedback sheets.

Restricted Focus

One major limitation to this study is that I did not conduct a comparison of African American students' and Caucasian students' interpretations of instructional representations. Information collected in this work only analyzed black students' responses and did not compare this information to other students. Such data can be gathered if future studies are conducted. This information can be extremely useful in determining a potential existence of and instruction-related cause for the achievement gap that persists between these groups of students. Additionally, it could provide insight into possible methods for reducing this gap.

Analysis of Responses

As a method to analyze students' interpretations of science lesson goals and purposes, I used student feedback sheets. I did not collect data to further support and strengthen the findings from the feedback sheets. My results would have been

strengthened if I collected and analyzed other forms of data such as assessments (exams, quizzes, projects, etc.), group discussions, and individual interviews with students. Because these data would have provided an opportunity for students to elaborate on the responses they shared on the feedback sheets, they would have allowed me to gain a more in-depth and accurate understanding of the students' interpretations. The use of multiple data sources could have addressed another limitation of the study, teacher-researcher bias.

Teacher-Researcher Bias

My dual role as both the teacher and researcher definitely could have produced a bias affecting the results. My comments or actions may have caused the students to write responses contrary to those they may have written if I did not have a dual role in this study. Another area where teacher-researcher bias may have been a factor is in the evaluation of the students' responses. My understanding of the students' responses may not have been accurate. Students' may have had different meanings than what I interpreted from their responses. Further methods of data collection could have helped to reduce this factor.

Sample Size

The sample size for this study is another limitation. It may not have been sufficient enough to identify a thorough extent of students' interpretations. Thirty-eight African American students were targeted for this study, but a larger sample size could have generated different results. Patterns may have emerged that were not observed in this study. Additionally, student mortality and blank feedback sheets confounded the problem with the sample size.

Student mortality

Another limitation to this research was my inability to accurately obtain information from all of the African American students. For each of the four lessons I researched, I was unable to collect feedback sheets from all 38 African American students. Considering the issue that a number of African American students withdrew from the middle school before all of the data collection was completed, the information I gathered from these students could not be used in the study.

Furthermore, new African American students were added to my team after data collection began; the data I obtained from them could not be included in my findings.

Blank Feedback Sheets

Some of the feedback sheets I retrieved were blank. Because I was unable to distinguish if students could not interpret the lesson or if they elected not to write a response, I did not include their data in my analysis.

Conclusion

The study I conducted for my research allowed me to gain a more extensive understanding of how my African American students interpreted lesson objectives from my teaching. My work was important because it allowed me to determine the affect of different instructional representations I employed. If implemented, the same practices could benefit other science educators. Furthermore, my work during this study allowed me to observe the benefits teachers can experience by conducting an action research project in their classrooms. Action research has enabled me to take ownership of my teaching by providing me with

immediate feedback during the research process that I could use to inform and improve instruction (Briscoe & Wells, 2002). Information gained has definitely helped me to grow professionally as an educator and a researcher.

Considering the fact that the achievement gap that existed between Caucasian and African American students years ago continues to persist in science and mathematics today, information obtained from such research can provide insight into the problem and possible methods to reduce this dichotomy (Seiler, 2001a; Hewson et al., 2001; Atwater, 2000). It is my belief that any additional understandings gained about how students interpret science lessons are extremely important not only in enhancing the effectiveness of classroom instruction, but also in addressing the achievement gap.

Appendix A

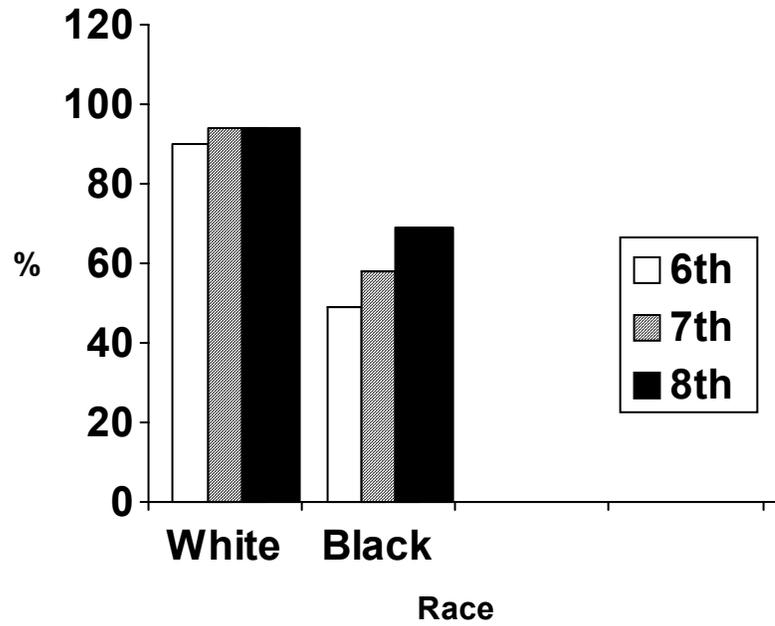


Figure 1. 2001 Reading Percentages of Students Scoring At or Above Grade Level By Race.

Appendix B

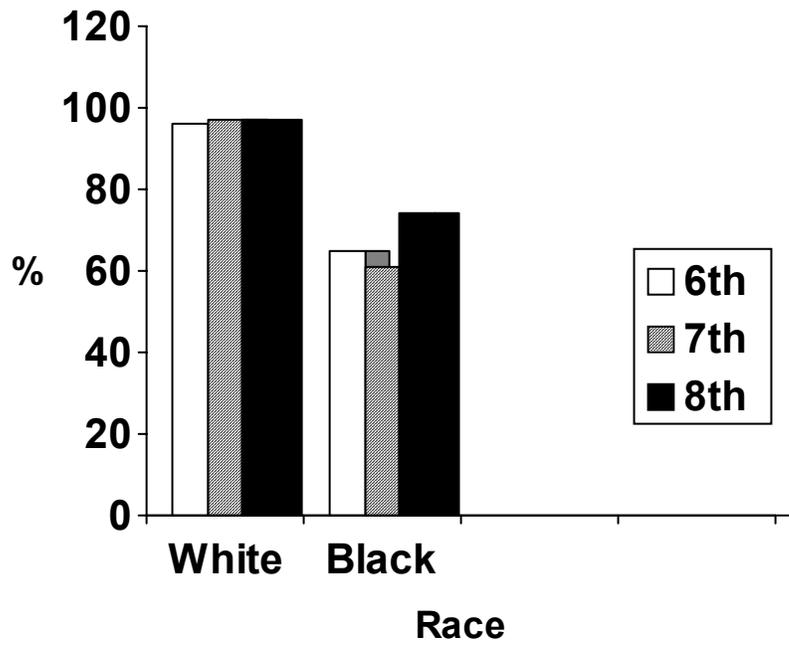


Figure 2. 2001 Mathematics Percentages of Students Scoring At or Above Grade Level By Race.

Appendix C

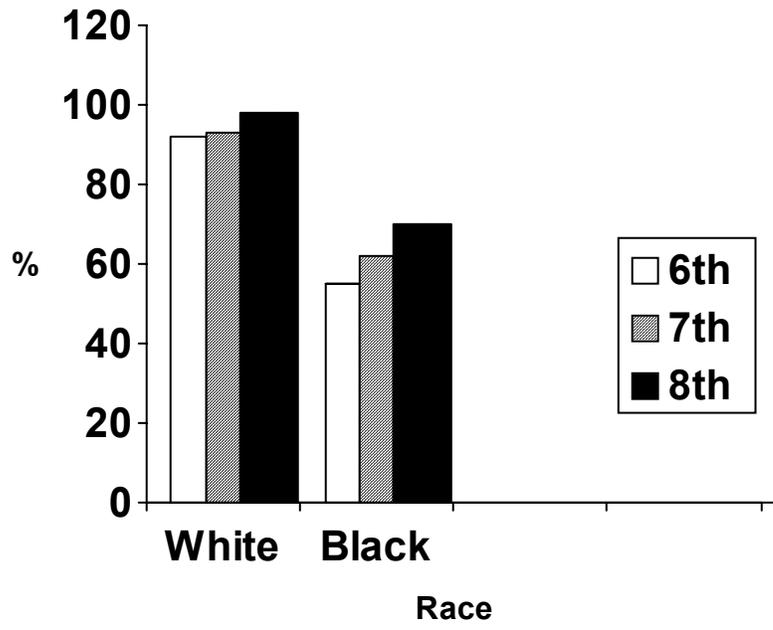


Figure 3. 2002 Reading Percentages of Students Scoring At or Above Grade Level By Race.

Appendix D

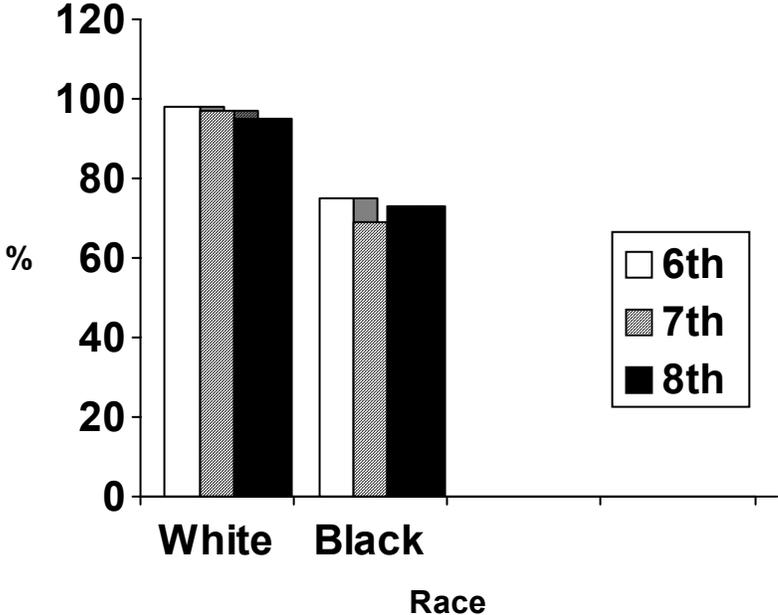


Figure 4. 2002 Mathematics Percentages of Students Scoring At or Above Grade Level By Race.

Appendix E
Teacher Objective Sheet

Miss Travis

Lesson: Energy Transfer Vocabulary Building
Instructional Representation: Science Textbook

Date:

Science Topic:

Instructional Goal (s):

Appendix F

Student Feedback Sheet

Instructional Representation: Science Textbooks
Lesson: Vocabulary Building

Feedback for Miss Travis

Please respond to the following question. Your response will help me to understand what you learned in science class and improve my teaching. Your response will not be graded and it will not count against you.

What was today's science lesson about? (Textbook Assignment)

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STUDENTS' ARTICULATION OF LESSON GOALS

Analyzing What African American Students Articulate as Lesson Goals: Assessing
Their Interpretations of Lesson Objectives with respect to Instructional
Representations used in the Science Classroom

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The focus of this research was to examine African American students' interpretations of objectives in relation to the instructional representations used to teach the science lesson. What did the African American students derive as the lessons' goals? How closely did the students' ideas about the lessons' goals align with the instructor's intent? Did the aforementioned alignment differ with the instructional representations used by the instructor? To respond to these issues, action research was used as the methodology for data collection. Data was collected from thirty-eight African American students exposed to four lessons and instructional representations. Students' responses on feedback sheets were used to assess what they derived from the lessons and how their comments aligned with intended goals. The results indicated that the students showed four degrees of articulation and their alignment with the lesson objectives varied with the instructional representation employed.

Analyzing What African American Students Articulate as Lesson Goals: Assessing
Their Interpretations of Lesson Objectives with respect to Instructional
Representations used in the Science Classroom

Nationally, apprehension has continued to rise in regards to the divergence in academic achievement between African American and Caucasian students. Research has revealed that African American students are achieving at a significantly lower rate than Caucasian students (National Center for Education Statistics-NCES, 2001). To address the achievement gap, the nation has made a commitment to provide equity in science education and settle disagreements of unfair practices in the areas of instruction and assessment. Therefore, equity is promoted to help equalize the learning field and ensure maximum levels of success. Atwater (2000) has described equity as “the quality of being fair or impartial...the settlement of controversies” (p. 155). Worldwide efforts have been made to provide impartial educational opportunities to all students, regardless of culture, gender, race, and or socio-economic status. Such efforts include, but are not limited to, the elimination of tracking and the implementation of standards-based curricula (Seiler, 2001a).

The issue regarding the achievement gap between minority and Caucasian students persists to be a topic of much speculation, research, and debate in education (Norman, Ault, Bentz, & Meskimen, 2001). The specific analysis of the African American population is important because this group comprises a significant number of minority students whose science achievement substantially trails white children (Hrabowski, 2002). Table 1 displays information obtained from NCES (2002); the

information shows a gap in scores between African American and Caucasian students on the Scholastic Assessment Test (SAT). Evaluation of poor student achievement on state and national assessments (e.g., state reading and mathematics exams, SAT) has resulted in a renewed focus upon African American students (Kober, 2001).

Research has identified that the difference in the success rates of black¹ and white students is not an isolated event affecting only one region in the country. This disparity has been observed across school districts and counties throughout the United States (Seiler, 2001a). Furthermore, the gap in achievement is apparent regardless of students' socioeconomic status or residential location. Inequalities that persist between black and white students' performance have been observed in lower, middle, and upper-class schools (Meehan et al., 2003; Hewson, Kahle, Scantlebury, & Davies, 2001). Additionally, the black-white achievement gap is just as significant for students of college-educated parents as it is for students of less-educated parents (Kober, 2001).

Though the gap in student achievement is apparent in all subjects, it is most prominent in the areas of mathematics and science (Hrabowski, 2002). Because of changes in national ethnic demographics and an increased demand for scientific literacy, educators and administrators need to take a more active role in reducing this gap. The population of African American and other minority groups is steadily growing; specifically in urban education settings. Luft (1998) has stated that, "Many school districts are ethnically and racially diverse and this diversity is increasing...the nation's largest school districts report a majority of students as African American,

Native American, Hispanic, or Puerto Rican” (p. 103). Growths in minority populations will naturally have a significant impact on education, especially in the urban science classroom. The disparities in students’ success are a problem that will continue to worsen if efforts are not made to eradicate it.

When addressing the issue of the achievement gap in science, it is important to look at instructional representations educators use to teach concepts. Considering the fact that a number of urban educators are still relying heavily on lecture-based instruction, insight into other instructional representations can be extremely beneficial. The primary use of lecture-based instruction is typically due to the fact that class sizes are large and resources are limited in urban environments (Luft, 1998). These factors influence urban teachers’ use of teaching strategies directed at the whole class learning (e.g., lectures, class reading, completing worksheets) rather than providing individualized instruction (Hewson et al., 2001).

Frequent use of lecture-based teaching has a number of limitations that are often detrimental to achievement (Tobin, Roth, & Zimmerman, 2001). One limitation is that the lecture method is teacher-focused. It places students in the role of passive receivers of knowledge and emphasizes the instructor’s delivery of information and concepts. In such a position, students have few opportunities to provide input or feedback.

Another limitation of lecture and other forms of teacher-centered instruction is that it tends to focus on memorization and low-level science process skills. Lecture

restricts the number of occasions students have to develop and use high-order skills such as synthesis or analysis. When students are not exposed to instruction that reinforces these higher order skills, their science knowledge and achievement suffers. Since black students are commonly educated in environments (e.g., low academic tracks, remediation classes, urban classrooms) (Goodlad & Oakes, 1998; Luft, 1998; Oakes, 1995) where low-level thinking is emphasized this places black students at a disadvantage and impacts their success in school, further adding to the achievement gap.

In this study, I attempted to examine African American students' interpretations of lesson objectives, how their declaration of objectives aligned with my intent as the instructor, and if this alignment differed according to the instructional representations used to teach the science lesson. I addressed the following: 1) With regard to lesson goals, how closely do the African American students' interpretations align with the instructor's intended objectives? 2) Does this alignment in interpretation vary with the instructional representations employed by the instructor?

For question one, I believe that African American students will interpret more information from lessons using the following instructional representations: inquiry labs, Microsoft Works™ (computer technology), or instructional videos. For these lessons, their interpretations of the lesson goals will more closely align with the intended objectives. Furthermore, African American students will interpret less information from lessons using instructional representations that focus upon passive

learning and memorization (Newton, Newton, Blake, & Brown, 2002; Peacock & Weedon, 2002), like the science textbook. Because of this, their interpretations for the textbook lesson will not align with the intended objectives. The literature supports my assertions that African American students respond most successfully to instructional representations that provide visual and hands-on reinforcement of concepts compared to textbook representations. Such visual and hands-on representations include but are not limited to the following: out of text diagrams and pictures, instructional videos, computer software, and inquiry laboratory activities, (Wu, Krajcik, & Soloway, 2001; Hewson et al., 2001; Roth, 2001; Michas & Berry, 2000; Kumar & Bristor, 1999). For question two, the literature indicates that students have differences in their ability levels, learning styles, and needs; therefore, I assert that I will also find differences in their interpretations of the lessons' goals (Tate, 2001; Atwater, 2000; Luft, 1998). Consequently, these interpretations of lesson goals will vary with the instructional representations employed.

Method

Participants

I was the sixth grade science teacher for 128 students. The 128 students made up five separate classes that met for 50-minutes a day. Of the 128 students, 38 African Americans participated in the study. Thirty-eight accounted for 30% of the students I taught. I selected the African American children as research participants on the basis of convenience.

Materials

During my teaching, all of the students were exposed to the following representations: the sixth grade science textbook, Microsoft Works™ (computer technology), inquiry labs, and science instructional videos. I selected four lessons for data collection. Each of the lessons used one of the instruction tools previously mentioned. The lessons were selected because they reflected instructional representations I frequently used during my science instruction

I called the first lesson the “constellation brochure project.” The lesson lasted for five fifty-minute class sessions and used technology as the instructional representation. More specifically, the students used the Microsoft Works™ computer program. During this lesson, students randomly selected the name of a constellation from a cup. They then conducted research on the constellation that was selected. Research information was first gathered from the textbook and related science books. The students then collected facts from school-approved websites on the Internet.

Information that was gathered about the constellations was recorded on research sheets provided by the instructor. After collecting information, the students designed an informational brochure for their constellation. The brochures were created on the computer using the Microsoft Works™ program. When all of the students completed their brochures, they presented the finished product and constellation information to the class.

Lesson two, a lesson on heat, lasted for one fifty-minute class session. The representation I used for the lesson was an instructional video. As an introduction to the new unit on energy transfer, the students viewed a video from the “Bill Nye the Science Guy” collection. It focused on the concepts of heat and energy. In viewing the video, students observed examples that pertained to the topics. Furthermore, they were introduced to vocabulary words. The information in the video was delivered through demonstrations conducted by Bill Nye, real-life examples, and music.

The third lesson lasted for one fifty-minute class session. This lesson focused on energy transfer and vocabulary building by using the science textbook as the instructional representation. To reinforce the concepts learned in the previous lesson, students completed a vocabulary building assignment. This lesson required the students to use their textbooks to define vocabulary words. The students were also challenged to connect these words to the concepts of heat and energy through various activities including word unscrambling and concept mapping. Vocabulary

skills such as correctly spelling, pronouncing, and alphabetically ordering words were also involved in completing this assignment.

The final lesson on heat and temperature lasted for two fifty-minute class sessions. This lesson incorporated an inquiry lab as the instructional representation for teaching these concepts. For this lesson, students were given a question: Does temperature affect the diffusion of food coloring in water? With a partner, students were required to design and conduct an experiment to answer this question. Groups were asked to describe their hypothesis, materials needed, procedures, and problems encountered. They were also instructed to collect data and graph their results. Because the groups' experimental designs differed, the information they obtained from the lab varied. Students were then challenged to answer questions about the lab. Finally, each pair of students presented their findings to the class.

Design and Procedure

Prior to the implementation of the instructional representations to teach these science lessons, I completed information on a teacher objective sheet. Information identified on this sheet included the date, science topic, and instructional goals for the lesson. A separate objective sheet was completed for each of the four instructional representations applied. An example of the teacher objective sheet for the textbook instructional representation is provided in Appendix A.

After completing each teacher objective sheet, I implemented the science lessons. The lessons exposed students to the science content as well as the selected

instructional representation identified for the objective. Following the lesson, I distributed student feedback sheets during the next class session. A separate feedback sheet was used for each of the four instructional representations implemented in class. On the feedback sheet, I asked the students to respond to the following question: What was today's science lesson about? The purpose for asking this question was to allow the students to supply me with a written response articulating their understanding of the lesson's goals. An example of a feedback sheet is provided in Appendix B. The responses the students made on the sheets served as the data for the study. I encouraged students in my science classes to respond to the best of their ability and informed them that their responses would not be graded or counted against them. For anonymity, they were instructed not to put their names on their feedback sheets.

For each instructional representation used, the documented instructor objective was compared to the responses on the corresponding student feedback sheet for that lesson. To do this, I first identified keywords from each lesson on the instructor's objective sheet. I chose the keywords that best reflected the objective and were likely to be mentioned by the students. These keywords were used to code students' comments on their response sheets. Tables 2 through 5 document the lesson objectives and the keywords I identified.

After identifying the keywords, I analyzed the students' responses on the feedback sheets and highlighted comments that included the keywords. I differentiated their response sheets into categories based on the number of keywords

identified (i.e., zero, one, two, etc.). Because the number of keywords differed for each lesson, these numbers were then translated into percentages. I calculated the percentage of the keywords by using the following equation:

$$\frac{\text{Number of Keywords Identified}}{\text{Total Number of Keywords for the Lesson}}$$

I used the percentages to make inferences about the students' interpretations and the extent to which those interpretations aligned with pre-determined instructional goals. These inferences were encapsulated in a classification system I called "degrees of articulation". The degrees of articulation consisted of four tiers. I called the first tier, the lowest one, "unsuccessful". For the unsuccessful tier, the students' articulation of the lesson goals did not align with any of the instructor's intended goals. Tier two, I termed "inadequate". Student responses classified as inadequate revealed that their articulation aligned 25 to 50% with the instructors' identified lesson goals. I labeled the third tier "adequate". The students' articulation of the lesson goals found in the adequate tier aligned 66 to 75% with the lesson goals. I termed the final tier, the highest one, "successful". For this tier, students' responses showed that they articulated all of the lesson goals, completely aligning with the instructor's objectives. The degrees of articulation for each lesson comprised the findings of this study.

Results

The process of comparing my lesson objectives to the students' comments resulted in the major finding of the study: the degrees of articulation. The students' remarks provided insight into how they interpreted the objectives of the lesson via instructional representations used to teach the science concepts. To illustrate the degrees of articulation, I give the number of students in each category and provide corresponding examples of the students' responses for each lesson.

The findings for lesson one are summarized in Table 6. Information presented in this table shows that the majority of students' responses in lesson one were inadequate. These comments identify that students' articulations only align with 25 to 50% of the lesson goals. Though a look at student responses shows that a large portion of the students was able to successfully derive that the lesson involved the study of constellations, few were able to state additional objectives. These data indicate that a significant number of the African American students inadequately interpreted the objectives of the lesson that used the Microsoft Works™ program (technology) as an instructional representation to teach the concepts (Shim et al., 2003; Skinner & Preece, 2003; Roth, 2001; Wu et al., 2001; Barab et al., 2000b; Mistler-Jackson & Songer, 2000; Gobert & Clement, 1999).

Data for lesson two is found in Table 7. Unlike in lesson one, lesson two shows that the majority of students' responses demonstrate an adequate degree of articulation. From the comparison between the students' responses and my instructional goals, I inferred that sixteen students articulated comments that aligned

with 66-75% of the objectives. In their comments, the students mention brownies, pancakes, popcorn, and ice statues; students encounter many of these items in their daily lives. These responses indicate that the students derived information from the instructional video that was couched in real-life contexts, thereby supporting the importance of relevancy in science learning advocated in the literature (Roth, 2001; Michas & Berry, 2000; Kumar & Bristor, 1999).

Table 8 displays data for lesson three. I was not surprised by the results I found. In my first hypothesis, I stated that I expected to find a larger portion of students having an inadequate degree of articulation from lessons using textbooks. This statement was consistent with the findings in that 23 students inadequately stated goals for the lesson that utilized the textbook instructional representation. The classification of their comments as inadequate denotes that the students were only able to share responses aligning with 25 to 50% of the lesson objectives. For lesson three, a number of students identified the general object of the lesson; they stated that the lesson involved the study of vocabulary and the concepts of heat and energy, but they were unable to mention other goals.

Information for lesson four is found in Table 9. As in the cases of lessons one and three, the results for lesson four, show that the majority of the students' comments reveal an inadequate degree of articulation of the lesson objectives. The twenty inadequate comments demonstrate that these students contrived comments aligning with only 25 to 50% of the lesson goals. These findings were not consistent with my expectations. For this lesson, the category showing the second largest

number of responses was the adequate degree of articulation; this finding aligns more closely with my expectations for this lesson. Eleven students were able to make adequate interpretations aligning with 66 to 75% of the objectives. Most of the students' responses mentioned that the lesson involved a lab or experiment and was focused on the concepts of heat and energy.

Combined results for lessons one, two, three, and four are represented in Table 10. The data collected relate that the majority of the total responses made by the African American students show an inadequate degree of articulation of lesson goals. Seventy-four of the students made derivations that aligned with only 25 to 50% of the objectives intended for the lessons.

Information in Table 11 shows the combined percentage of student responses for each instructional representation. From these percentages, I noticed that the largest percentage of unsuccessful responses was made in response to objectives given for the textbook lesson. Also, percentages observed in Table 11 identify that the largest number of successful comments were made in response to the goals of the lesson using the instructional video. These findings were consistent with my literature-based hypotheses.

Discussion

From this study, I generated a number of findings to help me answer my research questions. Through analysis of the African American students' responses, four distinct degrees of articulation of lesson goals emerged: unsuccessful, inadequate, adequate, and successful. The range of articulation is supported by

literature on the variability in student abilities and learning styles (Tate, 2001; Atwater, 2000; Luft, 1998). Because of these differences in students' needs, I expected the ranges in responses I found. The range spanned from completely unsuccessful to successful.

Students who were unable to identify any of the keywords were classified as having an unsuccessful degree of articulation. Their comments showed that their interpretations of the lesson goals through various instructional representations were drastically different from the objectives I intended. Conversely, students who mentioned all of the keywords showed a successful degree of articulation of goals. These students' responses completely aligned with the instructor objectives depicting the successful interpretations made by the students.

In summary, the data collected from this study allowed me to answer the two research questions: With regard to lesson goals, how closely do the African American students' interpretations align with the instructor's intended objectives? Does this alignment in interpretation vary with the instructional representations employed by the instructor? In regards to question one, I identified the information African American students interpreted from four lessons through analysis of their responses to determine the extent to which they aligned with lesson objectives. From this information, I determined the degrees of articulation. To answer question two, I used the degrees of articulation of lesson goals to observe if interpretations varied with the instructional representations used to teach the lessons. Not only did the information I obtained challenge me to recognize instances when students' comments

accurately depicted the goals (successful degree of articulation), but it also pointed out cases when students' interpretations diverged from what I planned (unsuccessful degree of articulation). The information gathered regarding the students' interpretations of lesson goals, the extent to which their interpretations matched my intended instructional objectives, and the variability of this alignment between student interpretation and instructor's intentions will enable me to improve my future practice. This implication for practice is only one significant outcome of the study.

I believe that this research provides a number of valuable implications for the field of education. These implications would be most beneficial to classroom teachers and their students. A major implication resulting from this study shows how action research can be implemented during classroom instruction. Utilization of this method of research provides educators with insightful information about what their students' derive and process from science lessons (Larson, Mayer, Knight, & Golson, 1998). Furthermore, it supplies teachers with the opportunity to analyze their teaching practices and the impact they have on student learning (Briscoe & Wells, 2002). Ultimately, data gathered from action research can help to improve instructional strategies of teachers and conceptual understanding for their students.

Another implication became evident during my review of literature. During this process, I located information about different instructional representations; however, I found a limited amount of information showing comparisons of various instructional tools. The results from my study imply that there is the potential that different instructional representations have various impacts on students' ability to

articulate information or lesson goals (Oakes, 1995). Further research could help to verify this. Such a study would require the implementation of multiple lessons involving the types of instructional representations of interest.

Considering the fact that the achievement gap that existed between Caucasian and African American students years ago continues to persist in science and mathematics today, information obtained from such research can provide insight into the problem and possible methods to reduce this dichotomy (Seiler, 2000a; Hewson et al., 2001; Atwater, 2000). It is my belief that any additional understandings gained about how students interpret science lessons and instructional representations are extremely important not only in enhancing the effectiveness of classroom instruction, but also addressing the achievement gap.

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Appendix A

Teacher Objective Sheet

Miss Travis

Lesson: Energy Transfer Vocabulary Building

Instructional Representation: Science Textbook

Date:

Science Topic:

Instructional Goal (s):

Appendix B

Student Feedback Sheet

Instructional Representation: Science Textbooks
Lesson: Vocabulary Building

Feedback for Miss Travis

Please respond to the following question. Your response will help me to understand what you learned in science class and improve my teaching. Your response will not be graded and it will not count against you.

What was today's science lesson about? (Textbook Assignment)

Author Note

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The basis for this study is a master's research and thesis project for the partial fulfillment of requirements for a degree in science education. Ms. Travis thanks Dr. Eileen Parsons, Dr. John Park, and Dr. Jenny Xiang for their assistance during the completion of this study.

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Footnotes

¹Black and African American are used interchangeably throughout the manuscript.

Table 1
Scholastic Assessment Test averages by race/ethnicity 1998-2002

Race/Ethnicity	1998-99	1999-00	2000-01	2001-02
SAT-Verbal				
White	527	528	529	527
Black	434	434	433	430
SAT-Mathematical				
White	528	530	531	533
Black	422	426	426	427

Scholastic Assessment Test was formerly known as the Scholastic Aptitude Test. Possible scores on each part of the SAT range from 200 to 800.

Table 2
Keywords used to identify students' understanding of lesson goals for the lesson using computer technology

Instructional Goals	Keywords
The students will research randomly selected constellations using books and the Internet.	Research, Search, Internet
The students will learn about constellations (groups of stars).	Constellations, Stars
The students will learn information about constellations, including: mythology (story), location, time of year, stars, etc.	Mythology, Story Information
The students will use the computer to create Informational brochures for their constellations.	Brochure, Computer

Table 3
Keywords used to identify students' understanding of lesson goals for the lesson using an instructional video

Instructional Goals	Keywords
The students will view the “Bill Nye the Science Guy” video to begin learning about the concepts of energy and heat.	Heat, Hot & Cold Cool & Warm
The students will begin to understand that energy is transferred through three methods: conduction, convection, and radiation.	Energy
The students will begin to understand that energy is transferred through three methods: conduction, convection, and radiation.	Conduction, Radiation Convection

Table 4
Keywords used to identify students' interpretations of the instructional representation for the lesson using textbooks

Instructional Goals	Keywords
The students will learn new vocabulary words and their definitions.	Vocabulary, Words, Definitions, Meanings
The students will learn how these vocabulary words are related to the concepts of energy and heat.	Energy, Heat
The students will complete activities to increase their vocabulary building skills. (i.e. word unscramble, ABC order, concept maps).	ABC order, Word Unscramble Concept Maps

Table 5
Keywords used to identify students' understanding of lesson goals for the lesson using inquiry labs

Instructional Goals	Keywords
The students will design a lab experiment.	Lab, Experiment, Project
The students will learn more about energy and temperature.	Energy, Temperature, Heat, Hot & Cold,
The students will observe how temperature affects the movement (diffusion) of molecules in water.	Movement, Spread, Dissolve, Melting, Molecules, Diffusion, Turning
The students will work in groups to complete the lab.	Groups, Partners, Teams

Table 6
Results for Lesson One (I.R. Microsoft Works™ Computer Technology)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	3	Learning. This project is about space. Because we are talking about it. It is very fun.
Inadequate	23	We used books and the <u>computer</u> for this project. We had to find main ideas.

Table 6 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
Adequate	2	<p data-bbox="1000 449 1385 705">It was about the <u>constellations</u>. Your constellations can be in a month. It showed patterns of the stars. <u>Myths</u>.</p> <p data-bbox="1000 758 1385 1014">We went to the <u>computer lab</u> to use the computers so that we could use the <u>Internet</u> and learn about the <u>constellation</u> that we picked from the jar.</p> <p data-bbox="1000 1087 1385 1503">This week's lesson is about <u>constellations</u>. We learned how the constellation was named, look, and who it was <u>named after</u>, etc. The <u>brochure</u> was to help us learn more about the constellation we had.</p>
Successful	3	<p data-bbox="1000 1583 1385 1837">The <u>brochure</u> project was a little exciting. We went on the <u>Internet</u> to <u>search</u> and to learn about Taurus and our <u>constellation</u>. I love the way</p>

Table 6 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
		we do our brochures but I can't figure out the <u>computer</u> . It was still a little hard.
		Last week lesson was about the <u>brochure</u> that we had to do on our <u>constellation</u> that we had chose. And we went to the <u>computer</u> lab and did <u>research</u> .

* 36 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Table 7
Results for Lesson Two (I.R. Instructional Video)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	3	How to bake brownies and pancakes and how to build an igloo.
		I think it was funny and helpful, amazing, crazy, learn.

Table 7 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
Inadequate	8	It was about <u>heat</u> and what causes heat. Also, what makes up heat. Science, <u>radiation</u> .
Adequate	16	<u>Energy</u> and <u>Heat</u> . <u>Heat</u> and how it moves and how it came to be. <u>Energy</u> of how it moves and goes on.
Successful	5	It was about <u>radiation</u> , <u>convection</u> , <u>conduction</u> and <u>heat</u> for example, <u>energy</u> transfer and power on a stove and how popcorn pops. It was about <u>heat</u> , <u>energy</u> . Learned about the 3 types of heat (<u>conduction</u> , <u>convection</u> , and <u>radiation</u>).

* 36 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Table 8
Results for Lesson Three (I.R. Science Textbook)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	7	<p>Today's lesson is about how to stay cool. How running makes you warm.</p> <p>To learn the things we don't know and to review for the things we know.</p>
Inadequate	23	<p>It was about learning important <u>words</u>.</p> <p>Yesterday lesson was about all types of <u>energy</u> and how energy is formed into light, heat, and other things.</p>
Adequate	3	<p>It was about the types of <u>heat and energy</u>, also about <u>vocab</u>.</p> <p>It was about <u>vocab</u> for our new unit <u>Heat and Energy</u>.</p>
Successful	2	<p>To learn the <u>words</u> of <u>energy and heat</u> and what they <u>mean</u> and how they work and are <u>connected</u>.</p>

Table 8 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
		We did <u>vocabulary</u> about <u>heat and energy</u> . We also did a <u>diagram</u> on heat and energy. We did <u>ABC order and heat/energy unscramble</u> .

* 34 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Table 9
Results for Lesson Four (I.R. Inquiry Lab)

Degree of Articulation	# of Responses*	Examples of Responses
Unsuccessful	2	Fun class.
Inadequate	20	We presented our <u>labs</u> . To learn about <u>heat and energy</u> .
Adequate	11	I think this science <u>experiment</u> was about <u>energy and heat</u> also the <u>temperature</u> was important.

Table 9 (continued)

Degree of Articulation	# of Responses*	Examples of Responses
		It was about how <u>heat</u> affects other <u>molecules</u> like food coloring.
Successful	2	<p>Today's science lesson was mainly about the <u>temperature</u> of liquid. On my <u>experiment</u>, I learned that food coloring <u>moves</u> faster in hot water than in cold water.</p> <p>We did an <u>experiment</u> on seeing how fast <u>warm, cold, and hot temperatures</u> of water <u>move</u> when you put food coloring in it.</p>

* 35 total student feedback sheets were collected. All of the sheets may not have been able to be analyzed (e.g., blank response sheets).

I.R. = Instructional representation.

Table 10
Combined results for all lessons

Degree of Articulation	Total # of Responses
Unsuccessful	12
Inadequate	74
Adequate	11
Successful	12

Table 11
Combined percentage of responses for the four instructional representations

I.R.	Responses	
	Unsuccessful	Successful
Computer Technology	8	8
Instructional Video	9	16
Science Textbook	21	8
Inquiry Lab	6	6