COMPUTER USES OF MIDDLE SCHOOL FEMALE AFRICAN AMERICAN SCIENCE TEACHERS

by

DONNA LENEVA WHITING

(Under the Direction of Denise Muth Glynn)

ABSTRACT

This study examined the science teaching and learning beliefs and experiences of African American female middle school science teachers who use computer technologies in science instruction. Teacher beliefs and experiences were explored, including how they believed students learned with computer technologies. Science education reform served as the context for this study and the theoretical framework of womanism or black feminist thought guided this study.

A qualitative descriptive case study combined with a life history design was conducted. Data from life history interviews, other interviews, documents (e.g., professional journey maps and field notes), and observations in the participants' classrooms were collected. The data sources were analyzed to describe participants' individual and collective beliefs and experiences. Results suggest that teachers use real-world applications of computer technologies to help studies think critically and problem solve.

INDEX WORDS: African American science teachers, Case study, computers, Technology-integration, Middle school science education

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DEDICATION

This dissertation is dedicated to my mother, Barbara Pace Whiting Baxter, who has always been my role model and guiding force.

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CHAPTER 1

INTRODUCTION

Background

In the last decade of the 20th century, a series of policy documents designed to promote widespread reform in science education were published. These documents encouraged new approaches to teaching and learning science and served as catalysts for current science education reform initiatives (American Association for the Advancement of Science, 1993; Czerniak & Lumpe, 1996; National Research Council, 1996a). One policy document, *The National Science Education Standards* published by The National Research Council (1996a) established "standards" for teaching and learning science at all grade levels. The science content standards "outline what students need to know, understand, and be able to do to be scientifically literate" (p.19) Standards-based science teaching promoted the use of inquiry, problem solving, and open-ended questions to improve student achievement. The National Science Education Standards also encouraged the use of computer technologies to support standards-based science instruction. Additionally, the International Society for Technology in Education (2000) published standards-based policy documents that outline how technology should be utilized in teaching and learning.

According to Czerniak and Lumpe (1996) education policy-makers maintain that adoption of a standards-based curriculum results in greater science achievement by all students, particularly those from underrepresented minority groups. Researchers (Ballone & Czerniak, 2001; Czerniak & Lumpe, 1996) have also stated that the role of teachers in standards-based science education reform has been limited. Reform leaders including higher education faculty, professional organizations, politicians, education policy organizations, and various government boards have primarily given teachers the responsibility of implementing reform-based instructional practices at the classroom level. According to Czerniak and Lumpe teacher beliefs about science teaching and learning are minimally reflected in reform policy documents and in reform-based curricula, assessments, and professional learning programs. Since teachers' beliefs play a key role in determining whether or not new curriculum and strategies are implemented in the ways designed, restricting their role in science education reform may result in limited educational change (Carroll, 1999; Haney, Czerniak, & Lumpe, 1996). There is also some indication that beliefs of teachers about science teaching and learning may be at odds with science education reform philosophy (R. Bybee, 1993; Czerniak & Lumpe, 1996; Jones & Carter, 2007; Levitt, 2001). According to Levitt, "If teachers' beliefs are incompatible with the philosophy of science education reform, a gap develops between the intended principles of reform and the implemented principles of reform, potentially prohibiting essential change" (p. 2).

Research about what teachers believe about science teaching and learning including the use of computer technologies in instruction has been conducted (Bailey, Householder, James, & Lamb, 2000; Crawley & Salyer, 1995; Cronin-Jones, 1991; Czerniak & Lumpe, 1996; Eberle, 2008; J.J. Haney & Julia McArthur, 2002; Judson, 2006; Pedersen & Totten, 2001; Savasci, 2006). However, there is still much to know about what science teachers believe and how their beliefs impact the types of instructional practices emphasized in reform documents. According to Calderhead (1996), the practice of teachers in the classroom is grounded in their beliefs about the purposes of education, schooling, and the students to be taught. Sims (2003) indicated that additional research findings suggested that beliefs held by teachers about everything from classroom behavior to their roles and responsibilities as teachers can impact instructional practice. Teachers also have beliefs about issues not related to their profession. Although these comprehensive beliefs impact teachers' practice, they can be differentiated from beliefs teachers have that are related to the educational process. Educational beliefs include beliefs about students and the teaching and learning process, about the nature of knowledge, about the roles of schools in society, and about the curriculum. Levitt (2001) indicated that all teachers hold beliefs, however defined and labeled, about their work, the subject matter they teach, and their roles and responsibilities as teachers.

Statement of the Problem

The purpose of this study was to examine the science teaching and learning beliefs and experiences of African American female middle school science teachers who use computer technologies in science instruction. It sought to identify their beliefs and document their experiences with and in science education. Current science education reform served as the context for this study.

Science teacher belief studies, particularly those related to the education of African American students in urban schools, have generally failed to include African-American teachers, male or female. Only a small number of studies that explore the beliefs of African American teachers teaching African American students in urban schools exists (Arrington, 1998b; Berliner, 2001; Delpit, 1995; Foster, 1990, 1997; Sims, 2003; Williams, 2006; Yarbrough, 2005). Delpit (1995) maintained that African American educators do not have access to the "culture of power" that white educators, by nature of their race, automatically have. This culture of power has "codes or rules relating to linguistic forms, communicative strategies, and presentations of self; that is, ways of talking, ways of writing, ways of dressing, and ways of interacting." Educators who belong to this "culture of power" routinely endorse, promote, and value the ideologies of their members. Therefore, the views that African American educators have towards education, particularly the education of African American students, are often ignored, devalued or marginalized, and left out of the sociohistorical record (Foster, 1990; Irvine, 2002; Williams, 2006). According to Williams "What those views contribute may be of assistance with both the retention of black teachers, and with helping present-day African American teachers increase their success with students" (p. 8). Furthermore, Hine (1994) and Williams (2006) maintained that African American women's beliefs and experiences should be researched, described, and interpreted with the same intensity and seriousness accorded that of other groups.

Research Questions

Two primary questions guided this study:

1. What are the science teaching and learning beliefs of African American female middle school science teachers who use computer technologies in instruction?
2. What are the science teaching and learning experiences of African American female middle school science teachers who use computer technologies in instruction?

The following secondary questions also guided the study:

1. How do African American female middle school teachers perceive their roles as science teachers?
2. How do African American female middle school teachers use computer technologies to teach science?
3. What experiences have influenced African American female middle teachers' beliefs about the use of computer technologies in science instruction?

Significance of the Study

While there are studies that explore all aspects of science teachers' beliefs, including their beliefs about science education reform and science teaching and learning in general, very few studies explore the beliefs of African American science teachers teaching African American students in urban settings. According to the National Center for Education Statistics (2007), approximately 80% of African American teachers reported teaching in urban districts where 50% or more of their students are African American. Academic underachievement of African American students is problematic. For example, the average scores of African American eighth grade students on the National Assessment of Educational Progress (NAEP) in science indicated a statistically significant increase from 121 in 1996 to 124 in 2005 (National Center for Education Statistics, 2007), their scores lagged behind those of all other NAEP reporting groups. The National Center for Education Statistics (2007) pointed out that school districts located in central cities and urban fringe areas have the highest enrollment of African American students. Kahle, Meece and Scantlebury (2000) maintained that gaining knowledge and insight about the educational beliefs and experiences of teachers teaching these students is critical, particularly when science education reform efforts have a goal of increasing the achievement of students attending urban schools.

The National Science Foundation (NSF), through its Urban Systemic Initiatives (USI) and Mathematics and Science Partnership (MSP) programs, funded professional learning projects in high poverty urban districts for over 10 years. A major goal of these reform-based programs was to improve the science literacy of all students in urban areas, including areas with large African American school populations (National Science Foundation, 1998). Many USI's and MSP's have sought to achieve this goal by providing science professional development, much of it content-based, for science teachers at all levels including middle school. However, as mentioned earlier, African American student achievement in science lags behind that of all NAEP reporting groups. Therefore, Sims (2003) maintained that examining the beliefs of urban teachers, including urban African American teachers, participating in reform-based science professional learning is worth taking into consideration.

An important component of this study was the purposeful inclusion of participants who use computer technologies in science instruction. A major emphasis of current science education reform is the integration of computer technologies into science teaching (National Research Council, 2005). According to several researchers (Bybee & Fuchs, 2006; Dani & Koenig, 2008) technology integration into instruction is imperative in order to adequately prepare students for 21^{st} careers and to create a scientifically literate population. Very little research exists that explores the beliefs and experiences of African American teachers, particularly those teaching African American students in urban settings, about the use of computer technologies in middle level science instruction. According to Ertmer (2006) beliefs teachers hold about teaching, learning and technology must be examined. Nespor (1987) and Hart (2002) indicate that teacher beliefs are affected by their experiences. Therefore, studying teacher experiences with science teaching and learning, including the use of computer technologies in instruction, is also necessary.

Theoretical Framework

The purpose of this study was to examine the science teaching and learning beliefs and experiences of African American female middle school teachers who computer technologies in science instruction. Because our social world is not fixed and is constructed with words, stories, and silence, voices of people of color are required for a complete analysis of the U.S. educational system (Delgado, 1995; G. Ladson-Billings & Tate, 1995). Accordingly, the theoretical framework of black feminist thought or womanism guided this study.

Black Feminist Thought or Womanism

The tenets of womanism or black feminist thought are rooted in the ideology of standpoint theory. According to standpoint theory, people gain knowledge through their positions or social locations. Standpoint theorists use the term positionality to describe how people's position in society determines how they interpret events. Yonezawa (2000) noted that this positionality is influenced by race, class, gender, and sexuality. According to feminist standpoint theorists, because women's roles in society are different from men, they have a distinct type of knowledge that allows them to see and understand the world in ways that are unique from and challenging to existing male-biased conventional wisdom. Bloom and Erlander (2003) explained that "Standpoint theory focuses on the production of knowledge that is emancipative, anti-oppressive, nonhierarchical, negotiated, and politically focused" (p. 341).

Black feminist thought or womanism represents the cultural, historical, and political positionality of African-American women, a group that has suffered slavery, segregation, sexism, and classism for much of its history in the United States. Womanism views the experiences of black women as "normative, not as a derivation or variation of black male or white female behavior" (Beauboeuf-Lafontant, 2002, p. 72). It seeks to understand the experiences, thoughts, and behaviors of black women, within the context of their particular cultural and historical legacies (Beauboeuf-Lafontant, 2002; Hill-Collins, 2000).

Arrington (1998a) maintained that African-American women create ideas and theories from a black women's perspective. These theories and ideas are the direct result of oppression black women as a group face. According to Hill-Collins (2000), black feminist thought is a critical social theory that

> Aims to find ways to escape from, survive in, and/or oppose prevailing social and economic injustice. . . . It reflects black women's efforts to come to terms with lived experiences within intersecting oppressions of race, class, gender, sexuality, ethnicity, nation and religion. (p. 9)

Because of race and gender, African-American women are a unique group in American society. Kim (2001) indicated that studying issues involving them, including those focusing on teaching, without realizing the impact race has on their lives provides an incomplete understanding of the realities of life for women of color. Feminist theorist, bell hooks (2000) provided insight into the relationship of race and gender for African American women:

> I can still recall how it upset everyone in the first women's studies class I attended – a class where everyone except me was white and female and mostly from privileged class backgrounds – when I interrupted a discussion about the origins of domination in which it was argued that when a child is coming out of the womb the factor deemed most important is gender. I stated that when the child of two black parents is coming out of the womb the factor that is considered first is skin color, then gender, because race and gender will determine that child's fate (p. xi).

A Womanist Conceptual Framework

The theoretical framework of black feminism or womanism places African American female teachers at the center of the educational research process. From this perspective, their educational beliefs and instructional practices are not marginalized or denigrated. Findings from educational research resulting from a black feminist or womanist framework has implications for the education of African American students and can be used to generate practice based on African American female teachers' perspectives (Howard-Hamilton, 2003; Tillman, 2002).

Figure 1 provides an overview of a conceptual framework for conducting educational research using a black feminist or womanist theoretical perspective. Using the tenets of black feminism or womanism, I created this framework to help guide this study. According to Miles and Huberman (1994)

> A conceptual framework explains either graphically or in narrative form the main things to be studied-the key factors, constructs or variables-and the presumed relationships among them. Frameworks can be rudimentary or elaborate, theory-driven or commonsensical, descriptive or causal. (p. 18)

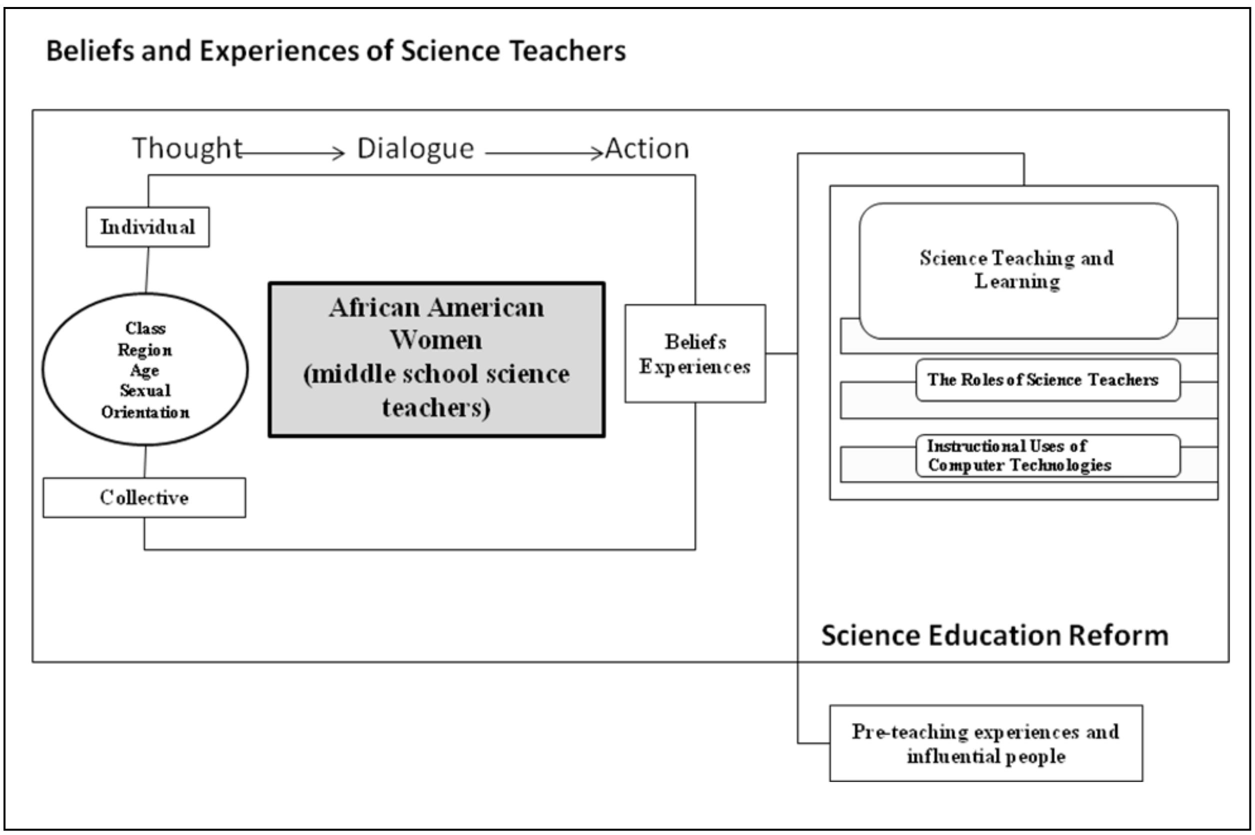

Figure 1.1. Conceptual framework for the study.

This framework places African American women at the center of the research process. It recognizes that according to the tenets of black feminism or womanism, there are common or collective beliefs and experiences shared by African American women as a group. At the same time, because of the diversity of class, region, age, and sexual orientation, individual women also possess unique beliefs and experiences. According to Howard-Hamilton (2003) through these contexts, the beliefs and experiences of black women can be revealed and understood. These multiple contexts can be explored using thought, dialogue, and action.

Using this framework, this study placed African American female middle school science teachers at the center of the research. Through thought, dialogue and action, this study, in the framework of science education reform, examined the individual and collective or common beliefs of participants about science teaching and learning, including the use of computer technologies, and their roles as science teachers. It examined these beliefs in the context of science education reform. It also examined the participants' pre-teaching experiences with science learning and people influential to their selection of a career in science teaching, experiences with science teaching and learning and experiences with the use of computer technologies in science instruction.

Overview of Methodology

This study was a descriptive case study. This methodology is supported by the framework that served as its basis. The framework guided the way data were collected, analyzed, and understood. According to (2001) a case study is an "intensive, detailed description and analysis of a particular individual, group, or event" (para 1). Case study was selected because it allowed the researcher to describe the professional world of participants. Merriam (2001) stated the "purpose of descriptive case studies is to present basic information about areas of education where little research has been conducted " (p. 38). Interviews, observations, and documents served to provide in-depth understanding of the participants' beliefs about and experiences with science teaching and learning, and the use of computer technologies in science instruction. Data collection took place from February 2007-May 2007. Interviews were audio taped. During the data analysis, field notes were used to provide detailed descriptions of activities.

Three prospective participants were recommended. They were all African American female middle school science teachers. The three participants each taught within the same system in two different schools from 8 to 26 years. Two taught eighth grade physical science for advanced students and earth science, and the other taught sixth grade earth science.

The data were analyzed in order to describe and compare participants' beliefs about and experiences with science teaching and learning and the use of computer technologies in science instruction. Chapter Three provides descriptions of all procedures.

The Researcher: Role and Subjectivities

According to Merriam (2002) it is important for a qualitative researcher to express her roles and biases when conducting a study. My role throughout this study was that of participant observer. I interacted with the participants in order to identify and understand their beliefs and chronicle their experiences as they related to this study.

Because of my professional role as a program director in a K-12 science, technology, engineering, and mathematics (STEM) outreach center located at a local institution of higher education (IHE), I knew two of the participants prior to the study taking place. They both participated in professional learning programs I directed in the school system where the study took place. Additionally, I had been involved in the district for approximately twenty years; first, as a middle grades science and mathematics teacher (five years); and then as a higher education partner (15 years). At the time of the study I was directing higher education and school district partnerships formed through two federally funded projects. Specific details about each of the federally funded projects are given in Chapter Three.

I am an African American female. My professional focus has been on mathematics and science education in urban settings. I have 25 years of experience teaching students or teachers in urban settings. Most of the students I have taught have been African American students who have not performed well on traditional standardized assessments. Most the teachers I have worked with as colleagues on the same school staff or on various projects have been African American female science teachers who teach urban African American students.

I value the thoughts and opinions of all people, including those held by positivistic researchers. I also recognize that people of both genders and of all races and ethnicities have suffered oppression. However, I also believe the knowledge making paradigms of African American women have been oppressed and marginalized in American society. I believe that because of this marginalization and oppression, research conducted by African American female scholars using critical or black feminist theoretical frameworks is seen as "outsider" research. Therefore, it is assigned a lower level of importance and the outcomes of the research are rarely applied when designing and implementing systemic education reform programs.

Assumptions

I made several assumptions when designing this study. First, I assumed that African American female teachers demonstrate normative behavior and therefore do not have to be compared to white female teachers. Second, I assumed that the descriptive case study design was an appropriate design. Third, I assumed that readers could make connections between the study and their interests and situations. I did not, however, assume that urban African American middle level science teachers use and are rewarded for using pedagogies of poverty to teach science. Haberman (1991) used the term “pedagogy of poverty” to describe the type of teaching found in urban schools with large numbers of minority children. He indicated that urban teachers are not as well-prepared as their suburban counterparts and are reward for using traditional teacher directed instructional practices.

Definition of Terms

African American—In this study “black” and African American were used interchangeably. African Americans are citizens of the United States who have origins in the black racial groups of sub-Saharan Africa. Most are descendents of African slaves brought to the United States during the raced-based Transatlantic Slave Trade, which lasted from the 16th to the 19th centuries. Many are also descendents of voluntary immigrants from Africa, the Caribbean, South America and elsewhere.

Beliefs—In this study, beliefs are defined as propositions or suppositions that are accepted as true by the individual holding them. They serve as guides for thought and behaviors (Borg, 2001). Educational or pedagogical beliefs are defined as beliefs about teaching and learning.

Computer technologies—In this study computer technologies are any form of a computer or computer-related technology including desktop computers, digital cameras, laptop computers or notebooks, personal digital assistants (PDA), digital media or MP3 players including iPOD’s, scientific probeware and global positioning system (GPS) units. The Definition also includes the use of software and Internet applications including web browsers and other web-based applications (video, video sharing, social networking, and email).

Experiences—In this study experiences are defined as events personally encountered, undergone, or lived through (Merriam-Webster, 2009).

Scientific inquiry—The activities students use to develop knowledge and understandings of scientific ideas including how scientists understand the world. These activities are multifaceted and involve making observations; posing questions; examining books and other resources; and using tools to gather, analyze, and interpret data (National Research Council, 1996a).

Summary

This introductory chapter has presented the background of the problem; stated the purpose of the study; offered a rationale for why a study of African American female middle school science teachers' beliefs and experiences is important; indicated the research questions, discussed assumptions of the study; and defined significant terms. Chapter 2 provides a review of the current literature related to science teacher beliefs. It also reviews literature related to the use of computer technologies in science instruction. Because little research exists about the beliefs of African American science teachers, male or female, relevant research literature exploring the general educational beliefs of African American teachers is reviewed.

CHAPTER 2

LITERATURE REVIEW

Overview

This study examined the beliefs and experiences of African American female middle school science teachers who use computer technologies in science instruction. This chapter discusses past research findings as well as underdeveloped areas in the research literature. It begins with a brief review of how beliefs have been defined and measured in the research literature and then examines three additional areas of research directly related to the study: research about science teachers' beliefs; research about the beliefs of African American teachers; and research about science teacher experiences with computer technologies. Current science education reform serves as the context for this study. This chapter focuses on relevant research conducted immediately prior to the publication of the *National Science Education Standards* (National Research Council, 1996a) through 2009. While important relevant studies conducted prior to 1990 will be included, this chapter is not a historical review of all research literature.

Literature Search Methods

The following on-line data-bases, indexes, and print sources were used to attempt to locate research literature relevant to the study topic: Library Catalogs at the University of Georgia and Georgia State University, ERIC, ERIC Thesaurus (Descriptors), Galileo, Social Sciences Citation Index, Women's Studies Abstracts, Women's Studies Index, Dissertation Abstracts, and the internet search engines, Google and Yahoo. A partial list of database keywords used was: teacher beliefs, teacher beliefs and science education, science teacher beliefs, African American teacher beliefs, black teacher beliefs, and computers and science education and several others.

Defining and Measuring Beliefs

Researchers in the fields of education and psychology have developed multiple and sometimes conflicting definitions of belief. Fishbein and Ajzen (1975) defined belief as “a person’s understanding of himself and his environment” (p. 131). Richardson (1996) defined beliefs as “psychologically held understandings, premises or propositions about the world that are felt to be true” (p. 103). Rokeach (1968) described three components common to all beliefs. These components were:

1. The Cognitive Component—This component represents knowledge.
2. The Affective Component—This component arouses emotion.
3. The Behavioral Component—This component directs action.

It is important to note that while Rokeach included knowledge as a subcomponent of belief, other researchers do not. Some researchers such as Nisbett and Ross (1980) viewed belief as a kind of knowledge rather than knowledge as a kind of belief. Others, such as Nespor (1987) maintained that because the affective component of belief is so strong in individuals, it operates, independently of knowledge. Pintrich (1990), differentiated beliefs from knowledge and maintained that while both influence cognitive process such as comprehension, memory, deduction and induction, beliefs determine how we organize information, define tasks and solve problems. Nespor identified four “features” of beliefs:

1. Existential presumptions—This feature emphasizes the deeply personal and unquestioned truth found in everyone. These are evident in the personal truths about

God. Teachers may hold existential presumptions about characteristics related to students including those related to ability, maturity and laziness.

2. Alternatively—This feature involves beliefs that differ from reality and defy logic. These beliefs can persist even when they are conflicted by reality. Beliefs do not have to satisfy a "truth condition" (Munby, Russell, & Martin, 2001).
3. Affective and evaluative aspects—This feature focuses on the levels of commitment and enthusiasm as activities are approached and completed. Nespor noted that the value a teacher gives to course content will influence the degree of commitment and energy given to the teaching of the content.
4. Episodic structure—This feature refers to the beliefs that "reside in episodic memory and draw power from previous episodes and events that color comprehension of subsequent events. Through episodic structure an individual's prior experiences can influence her or his beliefs" (Brindley, 1996 , p. 36).

Pajares (1992) provided a complete review and analysis of research focusing on beliefs including the relationships between beliefs and knowledge. Jones and Carter (2007) also reviewed belief constructs. Their review provided a historical synopsis of the research literature and includes research conducted after the publication of the Pajares article.

According to Bryan (1997), belief was an "ill-defined construct making it very difficult to study empirically" (p. 10). Czerniak, Lumpe & Haney (1996) emphasized that understanding teachers' beliefs is important since it appears that teachers' beliefs impact the successful implementation of science education reform efforts. Jones and Carter (2007) explained how various theoretical models have been used to "account for the multiple variables affecting decisions to engage in certain behaviors" (2007, p. 1073). Two widely used models are: the

Theory of Reasoned Action (Fishbein & Ajzen, 1975) and the Theory of Planned Behavior (TPB) (Ajzen, 1985).

According to the Theory of Planned Behavior (TPB) intentions were a function of three basic determinants: one is personal in nature, one reflects social influence and a third deals with issues of social control (Ajzen, 1985, 2005). Czerniak, Lumpe, Haney, & Beck (1999), used the TPB to examine science teachers' beliefs about the implementation of reform-based educational technology initiatives. Results of the study indicated that although teachers believed educational technology could improve instruction and meet student needs, they also believed many barrier exists that would prevent implementation. These barriers included the lack of adequate professional development, funding for equipment, large class sizes, and time for planning.

Qualitative and quantitative methodologies have been used to identify teachers' beliefs about science and science teaching and learning and then related beliefs espoused to instructional practice. Jones and Carter (2007) pointed out that the use of qualitative research methods " have enabled researchers to go beyond simply identifying attitudes and beliefs to documenting the complex system of beliefs while shedding light on the development of belief systems within individuals" (2007, p. 1073). Interviews (Skamp & Mueller, 2001; Tsai, 2002), teacher biographies and journaling (Stuart & Thurlow, 2000), and case studies (Abell & Roth, 1992; Zahur, Barton, & Upadhyay, 2002) are some research methods that have been used in science teacher belief research.

Science Teaching and Learning Beliefs

This section explores research on the epistemological beliefs of science teachers and the impact of these beliefs on instructional practice and participation in professional development. Jones and Carter (2007) defined epistemological beliefs as beliefs about science, science learning, and science teaching. *The National Science Education Standards* – NSES (National Research Council, 1996a) were used as a guide to select studies that explored the beliefs of science teachers in the context of science education reform.

The NSES (National Research Council, 1996a) delineated five student-centered instructional roles for science teachers: planner, facilitator, assessor, designer, and manager (Appendix G). Research indicated science teachers may have difficulties assuming these roles because of their epistemological beliefs. Research literature indicated that teachers' epistemological beliefs may be in conflict with the constructivist paradigms embedded in reformed-based instructional roles (Czerniak & Lumpe, 1996; Jones & Carter, 2007; Munby, Russell, & Martin, 2001; Tsai, 2002).

Relevant literature also indicated that epistemological and other beliefs science teachers have strongly influenced how they teach (Ball & Cohen, 1996; Hewson, Kerby, & Cook, 1996; Munby, 1984; Tobin, Tippins, & Gallard, 1994; Yerrick, Parke, & Nugent, 1997). This was demonstrated by a case study of two middle grades science teachers conducted by Cronin-Jones (1991). The teachers' had difficulties implementing a curriculum focusing on wildlife species because their beliefs were in conflict with the discovery-oriented instructional practices used in the curriculum. Each teacher believed the purpose of science learning was to learn facts. Haney and McArthur (2002) concluded that two kinds of science teacher beliefs functioned together in the science classroom: core beliefs and peripheral beliefs.

Other research has explored the relationship between belief, participation in reform-based professional development, and change in classroom instructional practice (Enyedy, Goldberg, & Welsh, 2005; Yerrick et al., 1997). Findings indicated that participation in reform-based professional development does not necessarily translate into reformed-based science instruction.

Yerrick et al. (1997) conducted a study of eight middle school science teachers enrolled in a two week summer professional development institute focusing on science inquiry. As part of the institute teachers experienced inquiry-based instruction and planned inquiry-based lessons. Findings indicated that two months after the institute ended, teachers' practices and lesson plans showed little evidence of inquiry-based instruction or planning. The study inferred that teachers' beliefs about instructional practices are not necessarily changed through participation in a two week summer institute. Other studies showed that teachers implemented standards-based instruction without believing that students construct their own understandings (Czerniak & Lumpe, 1996).

Science Teacher Roles

Much of the research literature on teachers' beliefs about their roles categorizes teacher roles related to knowledge of content, instructional practice, and knowledge of the learner (Carroll, 1999; Deemer, 2004; Haney et al., 1996; Levitt, 2001; Savasci, 2006; Tiberius, 2001). Kennedy (1991) described five models of teaching that represent science teachers' beliefs about the nature and purpose of teaching. Crawford (2000), in a study of a high school biology teacher who created and sustained an inquiry-based learning environment, found that the roles of the teacher changed based on varying instructional tasks. In a case study conducted by Bielenberg (1993) a seventh grade life science teacher believed her role as a teacher was that of a facilitator who supported the learning process. In the facilitator role, the teacher focused on asking and answering questions, modeling science techniques, roving, making suggestions, and moderating. The teacher believed her responsibility, as a facilitator, was to help develop independent learners and provide what she believed was a classroom environment to support this development. The environment included: "beginning instruction immediately when class starts, taking care of administrative matters after students are engaged in a task, and ignoring student diversions" (p. 7). According to Deemer (2004), creating classroom environments that encouraged independent, self-motivated learners was a critical role of a teacher. These types of mastery goal orientation learning environments stressed challenging learning situations, viewed failures as learning experiences, and emphasized self-standards for performance.

Research with Canadian health science teachers conducted by Tiberius (2001), organized teacher beliefs into four role related categories: the concept expert teacher role, the performance teacher role, the interactive teacher role, and the relational teacher role. The concept expert teacher believed the role of a teacher was to act as a resource learner. Concept expert teachers believed their responsibility was to maintain current knowledge in their field. They conveyed science and scientific knowledge using traditional transmission approaches such as lecturing. A case study of a veteran chemistry teacher conducted by Tobin and McRobbie (1996) reinforced the concept expert role of teaching. Tobin and McRobbie concluded that the subject of the study, Mr. Jacobs, developed a sense of teaching based on two major belief constructs: (a) knowledge exists separate from the knower, and (b) the teacher should have power in enacting the curriculum.

The performance teacher made performance their central role in teaching. These teachers believed that because they are the "sole agents of learning," students are products of their "molding and shaping." Interactive teachers believed they interact with students for the purpose of facilitating learning. They believed their responsibility was to examine their learners so that teaching strategies could be targeted to specific learning needs. Finally, relational teachers believed their major responsibility was to build authentic, trusting relationships with their students. These relationships served as the primary vehicle for learning. Teachers' beliefs about their roles as science teachers influences the ways in which they teach science.

African American Teachers' Beliefs

Qualitative research that examines the beliefs and experiences of African American female teachers, including the role they play in fostering the achievement of African American students, has been conducted in various social and cultural contexts (Delpit, 1995; Foster, 1997; Howard, 2001; Irvine, 2002; G. Ladson-Billings, 1994, 1995; Ladson Billings & Tate, 1995; Mitchell, 1998; Sims, 2003). Two major themes emerged from the literature: The first focused on the use of culturally relevant pedagogies to foster student academic and social achievement (Delpit, 1995; Irvine, 2002; Ladson Billings & Tate, 1995) and the second examined the intertwining of education and social justice (Howard-Hamilton, 2003; Howard Hamilton, 2003; Mitchell, 1998; Sims, 2003; Tyrone, 2001; Williams, 2006). There are many definitions of culturally relevant pedagogy. According to Cuban (1972), culturally relevant pedagogy refers to the utilization of teaching styles in ways that meet the needs of culturally diverse students. Howard used case study to identify three culturally relevant themes of four African American female teachers in a large northwestern city. The themes reflected the beliefs of the African American female teachers and are identified in the studies of other researchers (Beauboeuf-Lafontant, 2002; Foster, 1997; Irvine, 2002; G. Ladson-Billings, 1994; Sims, 2003). Table 2.1 summarizes each theme.

Several studies have shown a link between pedagogy used by urban African American teachers, their beliefs and attitudes, and their cultural backgrounds (Foster, 1990; King, 1993; Ladson Billings, 1994; Siddle Walker, 1993). For example, Ladson-Billings (1994) conducted a study of the beliefs and practices of eight teachers whom colleagues rated as highly effective teachers of African American children. The teachers believed all students could learn, viewed teaching as an art and believed their role was to give back to the community.

Table 2.1

Summary of Howard's (2001) Culturally Relevant Pedagogical Themes

Holistic Instructional Strategies	Culturally Consistent Communicative Competencies	Skill-building Strategies
• Goal is to produce students who are honest, responsible, respectful, cooperative, and act in ways that are consistent with social norms • Seeks to increase student awareness about socially and economically marginalized groups through community service	• Recognizes Black English Vernacular or BEV as a legitimate form of discourse while simultaneously emphasizing the use of standard English as a tool for expanding social, educational, and financial opportunities • Language and discussion used to connect school content to out-of-school experiences • Uses verbal opportunities as a form of student assessment • Recognizes Black English Vernacular or BEV as a legitimate form of discourse	• Purpose is to help students understand specific rules on academic tasks • Implementation depends on establishing a classroom environment that is conducive for academic and behavioral success • Stresses that all children are smart and that students need to put forth effort to improve skills linked to smartness • Places skill development over developing affectionate bonds with students

When examining the causes of the underachievement of African American students in science, typical research studies compared differences between underrepresented minority populations in urban areas and the mainstream ideas emphasized by the majority population (Berliner, 2001; Haberman, 1991; Kahle et al., 2000) . According to this body of research, traditional science curricula used in urban schools is a failure because it does not “bridge the gap between the world of the student and the world of science” (Prime & Miranda, 2006, p. 508). Research also indicated that beliefs of teachers about what their students should know and be able to do may have greater impact on student achievement than the curricula. For example, a

Prime and Miranda study of urban high school science teachers' beliefs about the characteristics needed for high achievement in science, "reveals that they (teachers) viewed the students as deficient in many of the skills, attitudes, and prior knowledge (for achieving in science) that are required" (p. 526). Prime and Miranda maintained that because of these beliefs, the teachers "watered down the science curriculum to eliminate complex concepts and deemphasize some topics" (p. 528).

Computer Technologies

Computer Technologies and Science Education Reform

While no national data exists that confirms the presence of technology in classrooms is increasing student achievement in science nationwide, the research literature indicates that many educators and those interested in education believe technology should be included as a part of science instruction if the classroom environment is to be relevant to students' daily lives (Lederman & Niess, 2000a; Statistics, 1999; United States Department of Education, 1999). According to Lederman and Niess science educators were aware of the expanding role and influence of technology in society. They were also struggling with the use and appropriateness of emerging technologies in the science classroom. Hurd (2000) stated

> . . . revolutionary changes have altered the nature and practice of science; a global economy has emerged, brought about by advances in science and technology; and the world of work has also changed. The current science education reform movement in the United States has been underway since 1970. From the beginning, there has been broad agreement that the traditional goals of science education are obsolete and that new curricula need to be invented. (p. 282)

In the *National Science Education Standards* published by the National Research Council (1996b) specific guidelines were not given regarding the use of technology in the science classroom or in science teacher professional development activities. However, the importance of the integration of technology and science instruction has been recognized by organizations, which focus on science education and technology integration. The International Society for Technology Education (ISTE) and The Association for Science Teacher Education (ASTE), along with other professional organizations, have created a set of technology guidelines designed to enhance subject matter focused educational goals in the preparation of teachers within the framework of the National Science Education Standards. According to the guidelines, technology should be introduced in the context of science content and technology and instruction should provide an understanding of the relationship between technology and science. Research studies also indicated that in order for technology to be successfully used in instruction it should be introduced in the context of the content to be taught (Byrom & Bingham, 2001; J. E. Hughes, 1998; Lederman & Niess, 2000b; Martin & Shulman, 2006). Lederman and Niess stated:

> Teaching a set of technology or software-based skills and then trying to find scientific topics for which they might be useful obscures the purpose of learning and using technology in the science classroom - to enhance the learning of science. Furthermore, activities involving technology should make appropriate connections to student experiences and promote student-centered, inquiry-based learning. Activities should support sound scientific curricular goals and should not be developed merely because technology makes them possible. (p. 345)

According to Byrom and Bingham (2001) successful technology programs provided opportunities for teachers to align technology with the curriculum, such as planning or training sessions where they develop lesson plans that use technology to achieve learning objectives specified by the curriculum. Curriculum integration with the use of technology involved the infusion of technology as a tool to enhance learning in a discipline-specific content area. Effective technology integration was achieved when students were able to select technology tools to help obtain information in a timely manner, analyzed and synthesized information and presented it professionally. The technology should become an integral part of how the classroom functions – as accessible as other classroom tools. ISTE (2001) maintained that although many teachers are moving along the continuum from being personal users of technology, many have not moved far enough in engaging their students. Martin and Shulman (2006) noted that in order to successfully integrate technology the teachers' historical role as the source of large amounts of information must change. While standards can inform practice, research which focuses on classroom teachers' learning and use of technology must also be examined. Hughes (1998) divided research focusing on practicing teachers' learning and use of technology in the classroom into three areas: (a) research on the barriers that impede teachers' progress towards becoming technology-using teachers; (b) research on factors common in "exemplary" technology – using teachers, and (c) research on the process teachers experience while learning to integrate technology.

Challenging Experiences with Computer Technologies

Many studies describe challenges faced by teachers attempting to utilize technology as a tool for instruction (Hadley & Sheingold, 1990; Johnson & Liu, 2000; Rosen & Weil, 1995; Winnans & Brown, 1992). For example, in a case study conducted by McGrath et al. (1997), 10 elementary, middle and high school science teachers participating in a professional development project expressed frustration when attempting to integrate a multimedia software package

(HyperCard) into classroom instruction. The goal of the professional development was to have teachers create their own ways of having students, working in groups, create multimedia science projects. Each teacher designed the content and extent of the science to be involved in the project, group assignments and sizes, assessment criteria and project length. Because researchers like Balestri and Ehrman (1992) suggested that the best way to learn science was to create a design studio in which to work, designers of the professional development felt that teachers could utilize their classrooms as their design studio. Therefore, the participants were learning how to use the software at the same time they were expected to integrate it into instruction. It is important to note that the participants were also novice computer users and had to overcome problems new computer users often encounter: saving files over old files, losing data and not knowing how to troubleshoot software and hardware problems. Their novice skills also increased their frustration levels. However, when asked about the learning process, participants did feel that "lots of learning" took place and that in addition to science and computers; other skills including organization, interviewing and dependability were learned (Broce et al., 1997). Other research literature indicates that teachers use computers in the classroom for other reasons other than instruction including managing student data and creating lesson plans (Means & Olson, 1995).

The literature suggests three key areas, which prevent teachers from successfully integrating technology into their classrooms:

1. Personal factors such as prior experiences, age, gender, teaching experience and computer availability (Rosen & Weil, 1995).
2. Environmental factors such as lack of on-site support, the absence of a computer resource teacher or a computer resource teacher who is part-time or doesn't

understand their needs and is therefore non-supportive, limited numbers of computers or limited computer time, not enough time for lesson plan development and not enough help supervising students when using technology (Hadley & Sheingold, 1990; Winnans & Brown, 1992)

3. Pressure to increase student achievement just because the technology is available. The technology was viewed as the "magic bullet" (Andris, 1996).

Successful Experiences with Computer Technologies

While the science research literature demonstrates that challenges to using computers technologies in classroom instruction does exist, other literature indicates that teachers seem to have overcome these and successfully used computers in the classroom (Hughes, 1998; Judson, 2006; Popejoy, 2003). According to Hughes, successful teachers report that personal motivation, commitment to students' learning and to their development as teachers, access to sufficient quantities of hardware and the support and collegiality they experience in their schools and districts contributes to their becoming excellent technology using teachers. In a qualitative case study, Popejoy described how a science teacher overcame her frustrations in order to integrate technology into instruction. The teacher of fourth and fifth grade students received eight classroom computers with high speed Internet access as part of a local district technology initiative funded by private grant funds. While the computers were placed in the classroom, the teacher received little support and professional development on how to utilize them in instruction. She reported being very frustrated by this. With the support of the researcher (Popejoy) as participant observer, the teacher was able to implement an Internet based astronomy research project. The computers were used "primarily for research, data analysis, and presentation" (p. 8). At the conclusion of the project, the teacher reported, "her science teaching competence grew with the increase in computer use in her classroom" (p. 8). This study also demonstrates the importance of providing classroom support to teachers attempting to integrate technology.

Several studies emphasize the importance of utilizing a professional development model that provides continuous support and classroom implementation assistance (Haney & Lumpe, 1995; Shroyer & Borchers, 1996). They also indicate that the use of this type of model results in the successful utilization of technology in the science classroom. Judson (2006), in a study of thirty-two classroom teachers, concluded that professional development emphasizing classroom technology integration should simultaneously focus on strategies that promote constructive teaching ideology. Judson maintained that while technology integration is not a goal of constructivist teaching, it should support teachers as they develop student – centered classroom environments. Vannatta and Fordham (2004) indicated that professional development combined with openness to change and a willingness to invest time and energy "above and beyond the call of duty" were the best predictors of classroom technology integration.

Teacher Beliefs about Using Computer Technologies

While the utilization of professional development models that support teachers is important for successful classroom technology integration, other research literature indicates that teacher beliefs are also significant (Dickard, 2004; Zhao, Shelden, & Byers, 2002). For example, in a case study of two seventh grade science and math teachers participating in the state of Maine's learning technology initiative, Garthwait and Weller (2005) concluded that teacher belief about teaching and learning impacted how technology was integrated into classroom instruction. The Maine Learning Technology Initiative (MLTI) provided laptops to all students at an entire grade level. Garthwait and Weller reported that Susan, one of the teachers in the study, “believed that her greatest responsibility was that her students learned science. Therefore, she perceived laptop use as a wonderful extra: assisting with organization and providing motivation” (p. 374).

In a case study of a fourth grade class, Russell, Bebell, Cowan and Corbelli (as cited in Garthwait & Weller, 2005) concluded that teachers with favorable outlooks related to computer use were more likely to modify traditional instructional approaches to include technology. Yerrick and Hoving (1999) cited several studies that inferred teachers’ beliefs and experiences influenced their future practice more than the nature of the technology itself (Borchers & Shroyer, 1992; Miller & Olson, 1994; Miller & Olson, 1995). However, the quality of the technology integration was dependent on teachers’ expertise and prior experience with technology rather than their beliefs alone (Garthwait & Weller; Judson, 2006). Teachers with prior computer expertise spent less time on technical issues and more time optimizing computers in instruction.

Summary

This chapter reviewed literature relevant to this study’s topics. The theoretical and conceptual frameworks of this study placed African American female middle level science teachers at the center of the research. However, there is very little research that explored the beliefs of African American teachers teaching in urban schools. and this research does not examine the beliefs of urban African American female teachers in science education. Therefore, a “gap” in the research literature has been identified. Studying the beliefs and experiences of urban African American female science teachers has particular implications for professional development and instructional practice in urban settings.

CHAPTER 3

METHODOLOGY

The methods and procedures used in this study are described in this chapter. This chapter is organized into eight sections: (1) research design, (2) participants, (3) system and school demographics, (4) data sources and collection, (5) data analysis, (6) trustworthiness, (7) limitations, and (8) summary. Human subjects' protocol procedures were approved by the university and the school district where the study was conducted.

Research Design

The purpose of this qualitative study was to examine the science teaching and learning beliefs and experiences of three African American female middle school science teachers who utilize computer technologies in science instruction. Specifically, their beliefs about their roles as science teachers and their beliefs about and experiences with the use of computer technologies in science instruction were examined. According to Merriam (2001), a research design must relate to the character of the research questions and be the most suitable plan for focusing on the research problem. A design that combined descriptive case study and life history was used. Creswell (1998), indicated that a case study researcher explores a single entity or phenomenon and collects detailed information about the case by using a variety of data collection procedures during a sustained period of time. Furthermore, according to Merriam (2002) the case has a finite quality in terms of time, space or location, or components such as number of individuals . Case study was the most appropriate method for this study because the case was bounded by level and subject examined: middle level science. The participants, three female African American science teachers, defined the case being studied. The case study methodology allowed me to describe the unique beliefs and experiences of the participants while simultaneously providing me with ways to reveal the intersections of their beliefs and experiences.

While case study was the most appropriate design for this study, life history research was also a necessary design. A life history is the history of a single life as told from a particular perspective (Hatch & Wisniewski, 1995). The theoretical and conceptual frameworks on which this study is based emphasize the importance of recording and comparing participants' individual and collective lived experiences through the use of their stories. According to LeSage (2005),

> Life history methodology is one way to develop a broader spectrum of information about each participant. It provides an alternative perspective in understanding the participant's context, the development of beliefs, and current teaching practice. Life histories enhance case study methodology as they provide insight into the participants past experiences and provide a context for understanding how these experiences may have impacted the professional lives and espoused beliefs of the participants. (p. 36)

Furthermore, according to Merriam (2002), "the tracing of a person, group, or institutions past is sometimes part of case study" (p. 52). Life histories, in-depth-interviews, and observations were completed and analyzed. Documents were also collected and analyzed.

Participants

The participants in this study were three African American female science teachers from two different middle schools in the same urban district located in the southeastern United States. These teachers were identified by district level teacher leaders based on their use of computer technologies to teach science and their willingness to participate in research concerning science education. District level teacher leaders were responsible for assisting teachers with subject-level technology integration activities. The researcher emailed and met with each of the principals of the three schools where the recommended teachers taught to discuss the study as required by district guidelines. Approval of each principal was required before the study could take place. Two of the three principals gave permission for the study (interviews, observations) to take place in their schools. The researcher then met with each prospective participant (two from School A and one from School B) to discuss the purpose and components of the study and answer questions. Each participant that agreed to participate was asked to sign a consent form (see Appendix A) and complete a Participant Information Form (see Appendix B). Participants selected Queenlateacher (Case One), Lucy Line (Case Two), and Zora Walker (Case Three) as pseudonyms for identification. Queenlateacher was in her late 30s and taught middle level science for 16 years. She had a bachelor degree in biology with a minor in education from a historically black college or university (HBCU) in Virginia. Lucy was in her early forties and taught for 8 years. At the time of this study, she was in her second year of teaching middle level science. She had a bachelor degree in mathematics from an HBCU in Georgia. Zora was in her late 50's and taught middle level science for 26 years. She had a bachelor's degree in biology from an HBCU in Tennessee and a masters Degree in Curriculum and Instruction from a large Catholic university in the Midwest. Pre-teaching experiences of each participant are described in the next chapter.

System and School Demographics

Middle schools in the school district provided for the education of students in grades six through eight. The 2006-2007 student enrollment was 49,773 (10,707 were middle school students). Approximately 9.3% of the student population received special education services and 2.7% received English to Speakers of Other Languages (ESOL) services. System wide, 75.0 %

of students qualified to receive free or reduced price lunch and were therefore considered economically disadvantaged. Approximately 85% of students were identified as belonging to an ethnic minority. Although there was some ethnic and cultural diversity in the student population, the dominant ethnic affiliation is African American. Table 3.1

gives an overview of demographics for the schools and system where this study took place.

Table 3.1

System and School Demographic Profile (Georgia Governor's Office of Student Achievement Report Card, 2006-2007)

Demographic Profile	School A Case One and Case Two	School B Case Three	District
Total Enrollment	951	482	49773
American Indian/Alaskan Native	0%	0%	0%
Asian/Pacific Islander	0%	1%	1%
Hispanic	3%	1%	4%
Black	97%	97%	85%
White	0%	0%	9%
Multiracial	0%	1%	1%
Students with Disabilities	10%	10%	9%
Students with Limited English	1%	1%	3%
Students Qualifying for Free/Reduced Lunch	78%	89%	75%

Data Sources and Collection

Data collection was divided into four parts: pre-teaching experiences activity, and follow-up interview, computer technologies interview, classroom observations, and document collection. Data collection took place from January 2007-May 2007. Originally, data collection was to begin with a pre-teaching experiences activity conducted with all participants simultaneously. However, due to numerous scheduling conflicts case three, Zora Walker, was unable to meet with case one, Queenlateacher, and case two, Lucy Line, throughout the entire study. Data Collection for Zora took place separately from that of Queen and Lucy.

Interviews were used as a major data source. Kvale (1996) states “The qualitative research interview attempts to understand the world from the subjects’ point of view, to unfold the meaning of peoples’ experiences, to uncover their lived world prior to scientific explanations” (p. 1). According to Merriam (2001) interviewing is the best technique to use when conducting intensive case studies of a few selected individuals, particularly when the researcher is interested in past events that are impossible to replicate (p. 72). In this study, interviews allowed for the collection of in-depth descriptive data in the participants own words. Semi-structured interview protocols were used during follow-up of the pre-teaching experience activity and for the computer technologies interview (see Appendix C). The protocols were designed to help guide the research while being open ended enough to allow each participant to openly discuss her beliefs and experiences. According to Hill-Collins (2000) this was a way to promote dialogue, an important component of black women’s knowledge construction. In each case, participants requested that the researcher schedule time to meet when individual interviews were required. Each participant preferred after school sessions and each happened to prefer different days. Interviews were scheduled with Queen each Friday, Lucy each Thursday, and

Zora each Wednesday. Each interview was audiotape recorded and the researcher took corresponding notes. The researcher transcribed the interviews as soon as possible so that she could examine the text.

Pre-teaching Experiences Activity and Follow-up Interview

This part of data collection was designed to examine the unique pre-teaching experiences of each participant. According to LeSage (2005), examining pre-teaching experiences was necessary to understand the impact of participants' previous experiences on their current situation and beliefs. This examination provided personal stories about how the participants have interpreted things that happened in their lives prior to becoming teachers. Foster (1997) stated that life stories "bring the experiences of blacks, including teachers, into view in ways that reveal the complexity of their experiences" (p. xxi). Furthermore, "lived experience as a criterion for credibility is frequently invoked by U.S. black women when making knowledge claims" (Hill-Collins, 2000, p. 257).

In this part, participants completed a pre-teaching experience activity, Professional Journey Map (PJM), (see Appendix D) and follow-up interview. The PJM was designed to elicit a pictorial representation or sketch of the unique experiences and people that critically impacted each participant on her pathway to becoming a science teacher. This sketch was then used to facilitate discussion and seek clarification of experiences and about people encountered. Queen and Lucy completed the PJM activity during a two hour after school session. After completing individual sketches, Queen and Lucy shared and discussed their sketches with each other and with me. The entire activity, including the conversations surrounding their sketches, was audiotaped. Zora completed, shared, and discussed her PJM sketch with me the next day in a two hour session held at the end of the regular school day. Zora's session was also audiotaped. In each case a follow-up interview occurred within two weeks of the PJM activity on each participant's scheduled day. The PJM Follow-up interview protocol, the sketch, and PJM activity transcriptions were used to guide each interview. The purpose of this follow-up interview was to allow each participant to discuss her PJM sketch components and elicit each participant's beliefs about their roles as science teachers.

Computer Technologies Interview

This purpose of this part was to encourage each participant to reflect on her experiences with using computer technologies in science instruction, discuss influences that caused each participant to use computer technologies the way she does, and to elicit each participant's beliefs about the use of computer technologies in science instruction.

Observations

The purpose of this part was to allow the researcher to observe each participant's experiences with computer technologies in science instruction and to look for connections between beliefs and instructional practice. In research, "observational data represents a firsthand encounter with the phenomenon of interest rather than a secondhand account of the world obtained in an interview" (Merriam, 2001, p. 94). The researcher's role in this process was that of observer as participant as defined by Merriam (2002). While the researcher participated in the classroom in that she was present, her actual role was that of information gather. Because she specifically wanted to observe participants using some form of computer technology in their classroom, observations were scheduled when this was taking place. Two fifty five minute observations were completed for Zora. One fifty minute observation was completed for Queen and one fifty minute observation was completed for Lucy. Due to time constraints and school conflicts, a second observation could not be conducted for Queen or Lucy. With each case, field notes were recorded during the observations. Immediately afterwards, the researcher reflected on the observations by elaborating on my field notes.

Documents

The fourth part of data collection involved document collection. Each participant completed a Participant Information Form, PJM sketch (see Appendix E), and provided the researcher with two lesson plans that included technology integration and one anonymous sample of student work. The lesson plans and samples of student work allowed her to look for connections between beliefs and instructional practice.

Data Analysis

According to Rossman and Rallis (1998) "data analysis in a qualitative research study is the process of bringing order, structure, and meaning to the mass of collected data" (p. 176). Data analysis and data collection are not two separate entities. Merriam (2002) stated, ". . . data analysis is simultaneous with data collection. . . analyzing data begins with the first interview, the first observation, the first document accessed in the study" (p. 14). Therefore, during this study, data analysis was an ongoing process.

Merriam (2001) identified three basic levels of possible data analysis: basic description, category construction, and developing theory. This study focused on the first two: basic description and category construction. Interview transcripts, observations and documents were analyzed. Much of the data collected from this study was in the form of narratives or stories told to the researcher by the participants. Specifically, these stories were in the forms of life histories, which represented long periods of time in the participants lives or short stories which were used to illustrate a point being made by the participants. These stories allowed the researcher to describe the beliefs and experiences of the participants according to the categories presented by the research questions.

This study, like most qualitative studies, produced masses of data. Data was analyzed using processes recommended by Miles and Huberman (1994). They outlined a three part cyclical data analysis stream: data reduction, data display, and conclusion drawing/verification. In data reduction, the researcher makes analytic choices that "sharpen, sort, focus, discard, and organize data in such a way that final conclusions can be drawn and verified" (p. 11). Data reduction is a process of "selecting, focusing, simplifying, abstracting, and transforming" and occurs continuously throughout the life of the study.

Data displays are organized, compressed representations that help to understand what is happening. They are developed from extended texts (field notes and interview transcripts) and take the form of matrices, graphs, charts or networks. According to Miles and Huberman (1994) data displays are designed to "assemble organized information into an immediately accessible, compact form so that analyst can see what is happening and either draw justified conclusions or move onto the next step of analysis the display suggests may be useful" (p. 11).

Conclusion drawing and verification refers to the process of making meaning of the data and testing and confirming findings. In conclusion drawing the researcher may record regularities, observe patterns, develop explanations and note possible configurations, causal flows and propositions. The process of conclusion drawing occurs throughout the study. Verification also occurs throughout the study. Miles and Huberman (1994) refer to verification as a "self-conscious effort to collect and double-check findings using multiple sources and modes of evidence" (p. 267). As indicated by Merriam (2001),

> Data analysis is a complex process that involves moving back and forth between concrete bits of data and abstract concepts, between inductive and deductive reasoning, between description and interpretation. These meanings or understanding or insights constitute the findings of a study. (p. 178)

Professional Journey Map (PJM): Pre-teaching Experiences and Follow-up Interview

Data analysis began with participants completing a pre-teaching experiences activity, the Professional Journey Map or PJM.. The researcher transcribed the dialogue from the Professional Journey Mapping (PJM) activity for each participant's PJM session. Each participant's PJM drawing, portion of the transcription where she explained her PJM, and the researcher's field notes were then used to construct the pre-teaching experiences story of each participant. Each participant's pre-teaching experience story was emailed to her, along with a copy of the PJM transcription, with portions where statements were made by her highlighted. Each participant read and reflected on her story before the follow-up interview. Before the individual PJM follow-up interview each participant and the researcher reviewed the pre-teaching story and the participant provided feedback by clarifying certain parts and/or adding additional information. No major edits were necessary. Any edits recommended by the participants were made after the follow-up interview and their document was emailed to each participant for her feedback. Each participant's document was reviewed prior to the computer technologies interview. Each PJM drawing was then compared and individual thematic categories of common experiences emerged. These categories served as the organizing framework for the creation of a conceptually oriented summary matrix display that allowed me to further compare, categorize, and draw conclusions related to participants' pre-teaching experiences.

Interviews and Observations

A basic comparative method described by Merriam (2001) was used to analyze interview and observation data. This basic method constantly compared particular incidents in the same or other sets of data. Interview tapes for each participant were listened to and transcribed after each interview session. Each participant was also assigned a color code to help the researcher organize the data. Each interview transcription was then placed onto a four column chart. Column one was left blank in order for the researcher to note themes emerging from the participants or from pre-established themes based on the study's research questions. Interview transcriptions were placed in column two. Field notes taken during the interview were placed in column three. Follow-up questions or ideas resulting from the interview transcriptions and /or field notes were placed in column four. The researcher then coded one transcription and completed a data matrix based on the coded transcript. The researcher then coded transcripts for the other participants based on the codes established from the first transcription, including the categories established by the study's research questions. When new categories emerged the researcher added them and evaluated ways to reorganize the matrix if necessary. This process of coding and recoding was repeated until a summary matrix was completed. A similar method was used for coding and creating a summary matrix of observation data.

Trustworthiness

According to Lincoln and Guba (1985) qualitative researchers must decide how they can persuade their audiences to attend to and trust the findings. Lincoln and Guba identified criteria for determining trustworthiness including credibility, transferability, dependability, and confirmability. In this study, credibility was established through the process of member checking. According to Merriam (2002) member checking is the process of "taking data and tentative interpretations back to the people from whom they were derived and asking them if the results are plausible" (p. 204). Member checks were conducted throughout this study. Participants reviewed their life histories and interview transcripts to make sure they accurately reflected their participant's thoughts and experiences. The utilization of multiple data sources was also used to establish credibility in this study. The data sources used were: the three participants, transcriptions of multiple interviews, teacher generated documents (the PJM drawings, and lesson plans), life histories, and the researcher's field notes. Transferability refers to how well the research findings can be transferred to other research. According to Gorski (1998) transferability is dependent on how well the researcher describes the experiences and participants. Dependability and confirmability can be established though an audit trail (Gorski, 1998; Lincoln & Guba, 1985). Confirmability was established by maintaining copies of all interviews, observation notes, transcriptions and other documents collected. Data and analysis procedures were reviewed by education professionals. Triangulation was established through the use of multiple data sources.

Limitations

Possible limitations existed in this study. The first related to sample size and selection. Because this study focused on only three participants, their beliefs and experiences might represent the "exception" rather than the rule, particularly as they relate to middle level African American science teachers. However, in order to gain a deep understanding of their beliefs and experiences it was necessary to use a small number of participants. Another limitation had to do with the honesty of the participants as they participated in the research process including their answers to interview questions and construction of their PJM drawings. Prior to this study taking place the district implemented an extensive audit of science instruction within all elementary, middle and high schools. The purpose of the audit was to determine what teaching practices were being used for science instruction and to identify science reform-based instructional practices that should be implemented. All teachers were presented with the results of the study and given a list of reform-based teaching practices that should be implemented. Through the use of triangulation and member checking the researcher hoped this possible limitation was minimized. Another limitation related to the number of observations that could be conducted. The school system where this study took place would allow data collection to take place for only four months. Additionally, school schedules, school policies, and the researcher's work schedule limited the amount of observations that could be conducted. Through the use of triangulation, the researcher hopes this possible limitation was minimized.

Ethical Considerations

Ethical considerations in qualitative research should be considered in three areas: fieldwork conduct, researcher-participant relationships, and in analysis of the data. The researcher explained the reasons and purposes for the research and reviewed consent forms with each participant. Consent forms were signed by each participant and confidentiality was extended to each participant. Participants selected pseudonyms and all identifying markers including location and names of schools were deleted and/or substituted.

Participants were told that if any component of the research made them uncomfortable then that component would be dropped. The researcher also told participants that she would be available by phone or email if they had questions or wanted to follow-up with any discussion. Participants had the researcher's email address, which was checked regularly as well as her cell phone number. Participants reviewed transcripts for accuracy. Any necessary changes were made based on their reviews. They were told conclusions or explanation reached from the data would be based on the researcher's interpretations.

Science Education Reform within the District

The school district where this study took place had been involved in two major mathematics and science initiatives funded by the National Science Foundation (NSF). Each of the study participants participated in professional development activities sponsored by the two initiatives. The first initiative was a five year initiative funded from 1998-2003 through NSF's Urban Systemic Initiatives Program (USI). According to the National Science Foundation (2001),

> The Urban Systemic Initiatives Program (USI) in science, mathematics, and technology education is (was) a comprehensive and systemic effort designed to enable fundamental reform of K-12 science and mathematics education in large urban school systems. Eligibility for the program is (was) limited to school systems in 28 cities having the largest numbers of school-aged children (ages 5-17) living in poverty as determined by the 1990 Census. The program provides (ed) significant support for 5 years to cities that have completed comprehensive planning and demonstrate readiness to make systemic and sustainable changes in the policies, practices, and procedures of urban school systems. (p. 4)

The lead institution for higher education (IHE) involved in the project was the one where the researcher works full-time. Approximately 50% of the researcher's time was allocated to direct project activities. One of the researcher's major responsibilities was to design and implement an annual 30-hour summer professional development academy for all mathematics and science teachers in the district. The science portion of each academy was conducted by science and engineering faculty from the IHE, other IHE's, and nationally recognized experts in mathematics and science education. Each academy was designed to increase science content knowledge and content pedagogical knowledge including the use of inquiry in science instruction. The roles of science teachers as outlined by the National Science Education Standards were also emphasized (see Appendix G). Each academy used a conference style format and participants were free to select which sessions they attended. An academy was held each summer beginning in 1999. While funding for the USI ended in 2003, additional funds were received through the district's participation in another major NSF funded initiative, the Mathematics and Science Partnership (MSP) program, to continue to implement a 30-hour summer academy through 2008. The summer academy was the only system-sponsored science professional development offered through the district each year and attendance was optional. Approximately 350 of the district's 1000 mathematics and science teachers (elementary, middle and high school) attended the academy each year. Case One, Queenlateacher, indicated she had attended all academies from 1999 through the summer preceding this study, 2006. Case Two, Lucy Line, indicated she attended one academy in the summer prior to the study taking place, 2006. Case Three, Zora Walker indicated she attended all academies from 1999 through the summer preceding this study, 2006. The researcher met Zora Walker in 2000 at the summer academy. The researcher met Queenlateacher in 1994 when she participated in a two- week professional development summer course directed by the researcher. The researcher had not met Lucy Line until the study took place.

Summary

This study used qualitative data in the form of life histories, interviews, observations, and documents (including field notes) to examine the beliefs and experiences of African American female middle school science teachers who use computer technologies in science instruction. Data analysis consisted of searching and comparing data for emerging themes, reducing data to form data displays, and forming with-in and across case comparisons. The next chapter presents with-in case research findings and a cross-case analysis comparing and contrasting participants' beliefs and experiences.

CHAPTER 4

FINDINGS

Introduction

The purpose of this study was to examine the science teaching and learning beliefs and experiences of African American female middle school science teachers who use computer technologies in science instruction. It sought to identify, document, and describe their beliefs and experiences with and in science education, including how they believed students can learn with computers and computer supported technologies. To do this the researcher invited three African American female middle school science teachers who used computer technologies to participate. Data collection was in the form of interviews, observations or documents created by the participants.

This chapter introduces and presents a within-case analysis of individual study participant's data. Within-case findings emphasize and describe key beliefs and experiences that emerged from the data as they relate to the study's research questions. Within-Case findings also present in-depth descriptions of the pre-teaching experiences and influential people that critically impacted each participant as she prepared to become a science teacher. According to LeSage (2005) past experiences provide insight into how teachers may have developed current beliefs.

It was difficult for participants to conceptualize their beliefs about science teaching and learning outside of the context of science education reform initiatives being promoted at the district level. As described in the previous chapter, the district had been involved in science reform initiatives for approximately ten years. Therefore, within-case findings about each participant's beliefs about and experiences with science teaching and learning, including the use of computer technologies in science instruction are presented in the context of these reform initiatives.

The chapter also presents cross-case findings in the form of data displays that collectively summarize and compare individual participants' key beliefs and experiences. The chapter is divided into two sections: (1) Within-Case Findings: Queenlateacher, Lucy Line and Zora Walker; and (2) Cross-Case Findings. Because the womanist framework used for this study seeks to give voice to a group that has been historically marginalized in educational research, the words, stories and interpretations, of the participants are used throughout the chapter.

Within-Case Findings

Case 1: Queenlateacher

Pre-teaching experiences. This sub-section describes the pre-teaching experiences of Case 1: Queenlateacher. It also identifies people she encountered on her way to becoming a middle grades science teacher. Queenlateacher's professional journey map depicting her experiences and people encountered is located in Appendix E. Queenlateacher is referred to as Queen throughout the remainder of the chapter.

At the time the study took place, Queen taught four sections of earth science and one section of physical science at the eighth grade level at School A. The physical science course was for "honors" level students at the school. Students were placed in the course based on grades received in their seventh grade science and math courses. Students successfully passing the course were exempted from taking high school level physical science. Earth science was the regular course offered for eighth graders. However, students in the accelerated course took one semester of earth science and one semester of physical science. At the time of this study, Queen had been teaching at the school for sixteen years and had taught all science subjects including earth science, physical science, and life science. Her influential experiences with science learning began in middle school. This is her story.

"I wasn't always Queenlateacher. I started off as Princesslastudent" so began Queenlateacher as she shares her biographical journey with Lucy Line and the researcher. She was raised in a nurturing middle class home in a large southeastern city with both parents and three siblings. Her mom "instilled values to love each other and help each other in any way we could." She received lots of help and support from her sister and two brothers who later went on to attend universities located in or near the city where she grew up. She placed her home and family at the center of her image surrounded by hearts.

She had early positive experiences with education. She attended elementary school at K. Elementary, a school located in the large southeastern city where this study takes place. One of the first faces she recalled was that of Ms. H, her 1st grade teacher. Ms. H. was the first teacher who let her know she could be successful in school. She pictured Ms. H with a smiling face in her drawing. "She believed in me and she motivated me." She realized after looking at her report card that "I must be good at this." She indicated that she did well on tests. "That was one of my strengths." During elementary school, her classes went on lots of field trips, depicted by a bus in her drawing. She doesn't remember specific places but does remember that she was only interested in science related trips. For example, one year her class went to visit a cylindrical panoramic oil painting depicting the Civil War Battle of Atlanta but she doesn't remember all she saw there because it was "not of "interest to me."

Her positive experiences with science education continued in middle school. She went onto B. middle school in the same district. She doesn't remember much about sixth and seventh grades but indicated that her homeroom and 8th grade science teacher, Ms. B. positively influenced her. Ms. B was her favorite teacher. She remembered Ms. B handing back her tests and telling her “girl you are going places.” She says she didn’t quite know what that meant but she liked the way it sounded. Ms. B recommended her for the Outward Bound Expedition, a series of outdoor education field trips for select students in the school. The middle school she attended had a partnership with Outward Bound, a nonprofit organization emphasizing learning through direct experiences with the outdoors. Students were able to go hiking, camping, and canoeing and in the case of Queen’s school, visit places outside of the urban area where the school was located. These trips allowed her to experience science related events outside of a school setting. She went to the Gatlinburg Aquarium (Ripley’s Aquarium) in Gatlinburg, TN as part of Outward Bound. She stated “I completed a scavenger hunt and really wanted to find the answers. Others were into a particular boy but I was really into that scavenger hunt.” She also went to Ruby Falls, an underground waterfall located in Chattanooga, TN and the Outdoor Activity Center, a twenty six acre forest with 3½ miles of hiking trails and a nature center located in the southeastern part city where this study took place. As part of her participation in Outward Bound, Queen walked part of the Appalachian Trail in the North Georgia Mountains and met a woman hiking the trail alone. “It really fascinated me that this woman was actually hiking the trail by herself. I believed my interest in hiking was developed that day.” At the time of the study, she regularly participated in outdoor activities including camping and hiking with her family. She was married and had two children.

“High school was like a locomotive. The train was moving at high speed.” She won science projects, went to a West Point Military Academy summer program and was part of the Junior Engineering and Technical Society (JETS). She won money and awards from General

Electric for her high school science project, went to Andover Preparatory Academy as part of a summer program for urban youth and was part of a math and science program at her high school. Queen couldn't attribute her high school success to any one person because she indicated the teachers were wonderful there [Ms. A, Ms. K, Mr. C (9^{th} grade physics), and Dr. B.]. "They loved science and they prepared the way for me." She was awarded an academic scholarship to attend a historically black college in Virginia. Her freshman year was "easy" because M. High School prepared her so well in math and science.

At first, she wasn't interested in going into teaching. She was interested in medical school. As an afterthought, she decided to get a degree with a minor in education. She majored in biology. She took the science courses required for her major, which included one year of general chemistry, one year of organic chemistry, one year of introductory biology and one year of physics. Each of her courses included a laboratory component. Only science majors were allowed to take these courses so the lecture and lab sections were small. She feels she was able to receive lots of attention from faculty. She also took genetics, microbiology, cell biology, molecular biology, and biochemistry. Dr. L, one of her education professors and the "sweetest man" encouraged her to go into education to "have something to fall back on." He came to see her while she was student teaching and told her "you are phenomenal." She realized during student teaching how much she really enjoyed teaching science and that she really was a "natural." Queen stated,

> I knew I expressed an interest in becoming a doctor because everyone else wanted me to be one. I knew it wasn't what I wanted. I really didn't know what else I could do, other than being an astronaut and I definitely knew that I didn't want to go into space. Actually, even though I had inspirational teachers, I never considered teaching. My teachers never

> talked to me about science teaching as a career. Dr. L. was the first person who told me it was OK to use my knowledge and love of science to teach. He told me that's where I needed to be and here's where I am.

Table 4.1 summarizes Queenlateacher's individual pre-teaching experiences and people encountered. Family and supportive non-family members at the pre-college and college levels encouraged her to become a science teacher. Early school and non-school experiences formed the basis for her entry into science teaching as a career. Teachers at all levels, elementary, middle and high school, served as role models and mentors.

Queen's Key Science Teaching and Learning Beliefs and Experiences

This section describes the key science teaching and learning beliefs and experiences communicated by Queen during the research study. Queen's findings were compiled from interviews, observations and documents she provided. Queen participated in several district sponsored professional development science education reform initiatives as discussed in the previous chapter. Queen indicated that she learned how to implement inquiry-based instructional practices in her classroom as a result of attending these workshops. Many of Queen's interview responses focused on inquiry-based teaching and learning.

Table 4.1

Queen's Influential Pre-Teaching Experiences and People Encountered

Case	Family Environment	People External to Family Unit	School Experiences	Other Life Experiences
Queenlateacher	• Both parents present • mother did not work outside the home • middle class • Siblings attended college • Supportive towards achievement in education	• elementary and middle school teachers as motivators towards educational achievement • high school teachers as motivators for educational achievement • college faculty member as advocate for science teaching career	• Science related field trips at the elementary and middle school levels • Summer science programs at West Point and Andover Prep • High school level participation in science contests • Extensive high school coursework in science and mathematics • College major in biology with education minor • Student teaching in college	• None identified

Beliefs about the Roles of Science Teachers

Queen's beliefs about the roles of science teachers were divided into two categories: classroom and non-classroom. Queen indicated the major classroom role of a science teacher was to help students use science to understand the world they live in. She believed students could understand any situation through the application of science processes. She explained

> When I taught life science, I conducted a water quality analysis of an imaginary pond. I created a scenario and told students the pond was located near a chemical plant and

people living near the pond were getting sick. Their job was to find out if the pond could be contributing to their illnesses. I brought in a jar of water from the pond near my house to test but I told them I had collected it from the pond near the plant. I added vinegar to the water to make it slightly acidic. I had already taught students about pH and how to conduct a chemical analysis. We'd also already completed a microscopic study of pond water. The students were able to decide if they wanted to conduct a chemical study or a microscopic study. They also conducted Internet research about previous chemical spills. Based on their data they were able to draw conclusions based on their data and information collected. Before that lesson, many students were not aware of how industry can contribute to pollution. Through that lesson I believe I helped them build that understanding. I believe this is the type of scientific investigation that is particularly useful to them because it has some connection to real-life events.

Queen also believed her role was to guide students to scientific understandings. She believed she was able to guide students in many ways and that no one way worked all the time. She indicated she used different approaches based on her students needs. How she approached science teaching depended on what she felt her students understood and what they were able to do and how much time was available to explore a topic. For her, the guiding process might have been a lecture or it might have been an open-ended lab.

The researcher asked if guiding students to scientific understandings meant that she believed students should be able to construct their own understandings of scientific processes. Queen stated "of course." She commented,

I have participated in several professional development workshops focusing on inquiry-based teaching and learning, which is based on constructivist theory meaning student

> should be able to construct their own knowledge. I think this is extremely important for my students. I believe that by constructing their own understandings, my students will learn to appreciate science and can hopefully apply it in their own lives. But left to their own devices students may develop misconceptions that are not easily alleviated. So I do have to guide them to correct understandings of scientific concepts. They have freedom to make choices in how they get to these understandings but I have to guide to those.

Queen indicated she ultimately wanted to guide her students to the understanding that science can help them improve their lives. She stated

> I used the water quality scenario because I want students to see how science can change people's lives for the better. We go on in the lesson to talk about using science to make change happen though problem solving. She went onto explain that a school paper recycling program was started by students after they noticed how much paper the school threw away each day. According to Queen, "paper was everywhere." Students searched the Internet and found a company that would collect paper, including notebook paper. The company delivered containers for each grade level. Students in each of her classes rotated the responsibility of collecting and sorting twice per week. The students called the recycling company to come and get the paper when the containers were full. They had to roll the containers out and pick them up once they had been emptied.

Queen stated

> I really have very little to do with this project. Students run it. I do have to sometimes make sure they stay on schedule. But otherwise, they handle it. They even meet with teachers twice a year to get feedback and they also recruit new students. I call them my recycling activists. I believe they will be advocates for recycling for the rest of their lives.

> Through their work, they have probably have influenced other students too. This is an example of what I think my role is. It started out after a lesson on reusing, reducing and recycling. It's been in place now for three years. Students come to the school knowing we recycle and they want to participate. That's what science has done for them and that's what I want it to do. Our students are empowered through this little recycling program. We do reward them because that's important. Students get trophies for sports and we give science trophies too.

Non-Classroom Roles of Science Teachers

Queen viewed herself as an advocate for African American children and believed that teachers who could not be advocates for children should not teach. She explained

> My role as a teacher is to make sure I do whatever I can outside of my class to immerse my students in science and help them in other ways too. These extra experiences really motivate them and they know I care about them becoming contributing members of society and perhaps future scientists or engineers. My colleagues share this belief and that's why our school sponsors science and math contests and clubs outside of the regular school day. We tutor our students after school and on Saturdays. We even do our science projects after school and on Saturdays because we know some of our students don't have the resources to complete them on their own. We have MathCounts (a national mathematics enrichment program and competition for middle school students) and First Lego (an international competitive robotics program). We take our students to the Space and Rocket Center in Huntsville each year. We do everything we can to expose our students to as many extra-curricular experiences as possible. My middle school science teacher recommended me for special programs and I do that for students who I see are

> interested in science. I help get them in special summer and afterschool programs. My middle school teacher helped me so I have to give back by helping my students.

Queen was bothered by the lack of recognition she believed African American teachers received. She expressed her belief that most national reports focused on the negatives about urban education, including poor teachers. She stated "White teachers are often depicted by the media as heroes. However, I believe that most schools with African American students are fighting the good fight and going beyond the call of duty. It's just never emphasized."

Inquiry. Queen indicated she was an advocate of inquiry-based instruction. She described inquiry as a process where students take the role of scientists to "uncover information, make discoveries and solve problems." She equated inquiry with the use of pre-test data to elicit students' prior knowledge, the use of various strategies like demonstrations, lectures to provide background knowledge and motivate students, the use of labs to give students opportunities to think and explore ideas, and the use of cooperative learning strategies to help students take responsibility for their learning.

Providing Background Knowledge and Motivating Students

Queen believed that lecturing was part of the inquiry process. She indicated that "many teachers incorrectly think the use of inquiry excludes the use of lecture as a teaching method." According to Queen, the teacher's role when using inquiry was to assist or facilitate the process and that facilitation might include the use of lecturing to provide background and motivate students. She stated

> I lecture as a way to give my students background knowledge. I feel they sometimes need background information before we can proceed. I use the lecture as a way to create student questions about topics and to spark their curiosity. I believe it's OK to lecture as

> long as it's not done as the exclusive means of science instruction. Some of my students do not have backgrounds where they've had lots of experiences outside of school and most of their previous science instructional experiences have been limited. For many of my students, science instruction has been in the form of language arts or art. Unfortunately, it may have been limited to opening a book and answering questions. I feel the pictures, short video clips, and demonstrations I normally use during my lectures to increase my students' interest in a concept.

Assessing prior knowledge. Queen indicated she gave a pre-test before every unit as a way to help her assess student's prior knowledge about a concept and to help her decide what opened-labs she would use during a unit. She also indicated that she developed unit pre-tests from released item Criterion Reference Competency Tests (CRCT) along with questions from her textbook publisher. She stated

> Once I give my unit pre-test, I have an idea of what students already know about concepts and what I need to focus on content wise. There is no point in spending lots of time on concepts the students already know. Using CRCT questions helps me hone in on the concepts and skills they need help with. While I do not teach to the test, I do have to recognize that it is used as the measure of student achievement by the district and the state. So, it is important that I utilize the resources the state provides. I do add questions from the publishers' test bank. The test bank allows me to select questions based on level of difficulty. I try to mix medium and hard questions together and sometimes a few easy ones too. I believe my unit pre-tests provide me with important information about my students and they really help me to gear my teaching towards the students' needs.

Queen grouped her pre-test data for all classes together to determine what experiments she would have students conduct for a given topic. She indicated that she would like to have been able to use different experiments for each of her five classes based on individual class data but believed it would be very difficult for her to manage different labs every class period. She stated

> Sometimes when I analyze my unit pretest data I realize that it would be better for me to uses different instructional approaches with different classes or to have individual classes do different labs. But I just do not have the time for the preparation that would require. Sometimes I will set-up lab stations and have different labs at each station but its time consuming and I don't always have enough materials. So, I stick with two or three labs per unit depending on the size of the unit. I do try and assign different homework based on individual student's needs. It may only be an extra worksheet for some students but that's what I am able to manage.

An example of an inquiry-based lab. Queen provided an example of an Inquiry-based lab she used during a meteorology unit. She stated

> Our school business partner purchased a weather station some years ago and had it installed. It includes a barometer (measures atmospheric pressure), a sling psychrometer (measures relative humidity), a thermometer (measures temperature), an anemometer (measures wind velocity), a windsock (measures wind direction), a rain gauge (measures the amount of liquid precipitation) and a compass (measures direction). I started the unit by reviewing what each instrument does and how to use it. I then gave each cooperative group a chance to go out to collect the data for the class each day during the unit. The data was recorded on a large spreadsheet hanging on the wall. At the end of the two-week period we compared data for the different classes to the actual weather as recorded by the

National Weather Service. Each student was also asked to write their observations about the weather each day in their science notebooks. They were then asked to use their data along with historical data to predict what might happen during the same period the following year. Each group drew conclusions, prepared a presentation and reported their findings out to the class. Each group emphasized different aspects of the data. For example, one group may have focused on temperature and another may have focused on barometric pressure. I let them choose what they wanted to focus on and how they wanted to communicate their findings to the class.

Queen indicated that during the one week summer academies she attended for many years she had opportunities to work with higher education faculty to review content and conduct inquiry-based labs. She believed those opportunities helped her to better understand what she would be teaching during the upcoming year. However, according to Queen, the opportunity to conduct labs in the summer with faculty had not necessarily transferred into classroom practice. She stated

> Although it has been valuable for me to go through labs and deepen my content knowledge not all of what I have done has been implemented in my classroom. For example, one summer we studied speed and velocity using a roller coaster lab. We used tracks, model cars, and photometers to measure distances and time and then calculate velocity. This lab was phenomenal. It really would have allowed my students to conduct a rigorous inquiry-based lab using technology. But because I was unable to get the necessary materials I could not replicate it in my room. I did find a similar experiment using paper, a ping pong ball, meter sticks and stopwatches. Although not as high level, it does help students understand the concepts. My principal allocated some funds from the

> school budget to purchase two photometers and I rigged up an old hot wheels track my kids had so students can at least see how photometers can be used in science experimentation. But one set is just not enough.

Using cooperative learning strategies. Queen also discussed her use of cooperative learning in detail during the discussion following her classroom observation. She stated she believed in cooperative learning approaches for two major reasons: (1) They helped students take responsibility for their learning; and (2) They helped her become a facilitator of instruction. She also believed the routines and procedures that are a normal part of the cooperative learning process helped her with classroom organization and management. She stated

> I am constantly looking for ways to become a better inquiry-based science teacher. I really do believe it’s the best way to teach and the best way for my students to learn. The use of cooperative learning strategies has really helped me to realize this.

Queen went on to explain that even though she had been exposed to some aspects of cooperative learning in college, she spent her first two years in the classroom using traditional teaching methods almost exclusively. She stated

> Frankly, I was looking for new instructional strategies when I attended a cooperative learning in science classroom workshop. It was only a week-long but it was enough to get me started. Frankly, I remember I was exhausted. I spent hours after school setting up experiments. I remembered from college that cooperative learning might be a strategy I could use to help manage my classroom and get the students to take more responsibility for their learning. That was my motivation for attending.

She indicated she had been using cooperative learning strategies for almost fourteen years. She attended numerous workshops and used a variety of strategies including group investigations and games tournaments.

Queen believed that cooperative learning strategies are important for student learning in science because they allow students to discuss and share ideas. She believed that African American students particularly benefit from the oral discourse she thought was part of the cooperative learning process. The researcher asked her how she believed her students benefitted from oral discourse. According to Queen

> My students like to talk. I think that's common for most middle school students, not just African American students. I believe oral discourse helps students remember concepts. We have to take into account learning styles research when we teach and provide opportunities for students who learn best through oral means to express themselves. I think there has been too much emphasis in education on "controlling" African American children and rewarding the ones who are quiet with inflated grades. I've had students who received high marks in previous science courses who struggle in my course because they have to show real evidence through oral and written discourse that they understand. Conversely, I've had some of the real talkers' exhibit brilliant understandings of material and yet they may have been labeled a trouble maker in previous courses because they just couldn't be quiet and answer questions out of a book. I believe that communicating ideas about science helps students learn.

"The teachable moment." Queen also explained that students often brought up topics to discuss related to science and that she would spend class time talking about issues important to them. Queen stated that she believed in using current events to teach science. Therefore, when

students brought up issues or issues appeared in the news media she would ignore her lesson plans if she felt it was important to discuss issues, including non-science issues, in class. She stated

> Teachers need to be aware that sometimes it's impossible to continue with a lesson plan if world issues or for that matter neighborhood issues interfere. I hate to use 9-11 as an example because it seems so obvious. But you may not realize that on that day we were told about what was taking place and the principal talked about it for a few minutes over our Intercom system. We were then told to go back to our normal instruction. It was such a shocking event that students and the staff could not focus on the instruction planned for that day. Instead we set-up TV's in various classrooms and spent the rest of the day watching and discussing what was happening with our students. Public education in Georgia is so test-driven that sometimes common-sense approaches to teaching and learning suffer. I find it difficult to understand how teachers can continue with planned lessons when something exciting is happening in the world. I believe this is referred to as the "teachable moment." For example, when a Space Shuttle is taking off, I take the time during class that day to try and show the lift-off live or at least talk about it using the NASA website. The NASA website also has great videos and photographs related to all NASA initiatives. We may do an experiment focusing on the goals of the mission or some aerospace engineering concept related to it. I may try and relate my specific subject matter or I may not. It just depends. Students need to know that science is happening all over, all the time. Also, using "the teachable moment" is an excellent strategy for orchestrating discourse in science. Students naturally express their opinions related to current issues.

"The use of scientific tools." Queen believed that it was important for students to use scientific tools to study science. She defined scientific tools as science equipment that should be found in any basic science laboratory. Queen listed very simple items like beakers, Erlenmeyer flasks, and test tubes to more complicated items like probes and graphing calculators as examples. She believed the use of scientific tools allowed students to replicate what practicing scientists do in the 21st century. Queen indicated that practicing scientists solved problems faced by society or made new discoveries. She cited discoveries of new medications, space research, and medical treatments for cancer as examples of work conducted by scientists. According to Queen

> Some teachers, particularly those with little science backgrounds, are afraid to actually let middle school students conduct experiments, particularly inquiry-based experiments. They have safety concerns. Their concerns are probably valid since they don't' really know anything about science teaching and have little experience with science. But I believe students must have these experiences because through them they develop a love and appreciation for science. And of course I think it increases their ability to solve problems. Science teaching without student experimentation makes no sense. Collecting and analyzing data is what science is about. And science teaching without modern scientific tools makes no sense either. I understand that sometimes as a middle school science teacher I have to resort to using paper cups instead of beakers or straws instead of pipettes but I really don't like to. I want my students to feel like scientists and using what scientists use is a part of it. It's motivational and exciting for them to know they get to use what real scientist use.

Queen indicated that very little money had been allocated by the district for the purchase of science equipment and when the district purchased equipment, it normally took one school year to receive it and in some cases it was never received. Queen believed the No Child Left Behind law's emphasis on mathematics created a problem for science teachers. She indicated that because at the time the study took place, Adequate Yearly Progress (AYP) was based on student achievement in mathematics and reading, the district had focused all of its resources on those two areas. According to Queen, there was no follow-up by the district to make sure science teachers had the necessary materials to implement inquiry-based labs.

Beliefs About and Experiences with Computer Technologies

Queen identified three ways in which she believed computer technologies supported science learning by her students: (1) They increased her students' knowledge of the world around them and helped them to think on a global scale; (2) They helped her students collect and analyze scientific data; and (3) They helped motivate her students to want to learn science. She stated

> My students are motivated when they have opportunities to use computers. They are digital people and are naturally comfortable with computers. Their learning curve for when teaching them to use a new piece of software is low. It really doesn't take them long. Of course, I am comfortable using computers myself and trying new things. Since I am, I don't have problems trying new technologies in the classroom. I am not afraid and I think I pass my fearlessness onto them.

Queen had "acquired" some science software programs, including gaming and simulation software. She indicated that she regularly used these in her classroom to demonstrate science concepts and to allow her students to conduct experiments. Queen believed the software allowed her students to experience science and apply it in real-world situations. When asked to provide an example of how she used science software Queen talked about a physical science program called *Pinball Science*. She stated:

> My students love *Pinball Science*. I have five copies and I break students into groups of three when we work with it. Half the class can be on the computer while the other half works on something else. Then we rotate after 20 minutes. Students are able to study and apply physical science concepts, friction for example, by creating a pinball game. They must learn the concepts in order to create the game. The software is easy to use, so it does not take much time for the students to learn how to use it. Students are able to use their knowledge, and learn new concepts while creating a game. It really is real world and of high interest for my students. Gaming is something they are used to doing on a daily basis and being able to create a game is motivational for them. When they are motivated they learn the material.

The researcher asked Queen how she measured student learning when using a program like *Pinball Science*. She pointed out that students are required to provide written evidence of what they learn in their science notebooks each day plus she gives short quizzes that include multiple choice questions and short answer questions weekly. Queen indicated the quizzes are necessary for three reasons: (1) they helped her know what concepts students mastered; (2) they helped her decide if remediation was necessary; and (3) they provided students with practice for the CRCT since the questions are phrased in a manner similar to the CRCT. She indicated that the use of Pinball Science was effective in helping her students understand physical science concepts. She stated

> I don't do a separate lesson on friction and very little on simple machines. I use the game to teach those concepts and I check for understanding using questions. I haven't had a major problem with students not understanding the concept using the software. They do pretty well on the quiz and I usually don't have to re-teach so I know they can learn using the technology.

Queen believed that by using computers, particularly the Internet, she was able to provide her students with information and experiences she could not do so with the limited science materials she had. She stated

> Technology has particularly benefited science instruction. I used to have to search for a video I could show in the class. But now I can easily use United Streaming or other video sharing sites. Actually, the video is secondary. My students don't have to feel isolated. The Internet has really brought meaning to science instruction. We can easily discuss any subject, any place and find more information. We can go where anything is taking place instantly, sometimes in real time.

Queen indicated the school plan had a technology component that emphasized the use of productivity software by all students. The goal was to have students understand and be able to use the basic Microsoft Office programs: Word, Excel and PowerPoint, before they went to high school. Therefore, Queen regularly used the programs to have her students write reports (Word), create spreadsheets and charts and graphs (Excel) and create presentations (PowerPoint). The school plan also called for students to understand and be able to conduct research using the Internet. She was very enthused about students in the school understanding how to use these programs and the Internet correctly. She believed their mastery would help students succeed not only in high school and college but in future employment. She stated

> Being able to use productivity software and the Internet are very valuable computer skills. While I can use a program like *Pinball Wizard* to teach science concepts, students may never encounter this program again. However, being able to use Office beyond a basic level and use the Internet to find information and conduct research are skills the students can carry with them. I like that Office is called productivity software because that's what it does for my students, it makes them productive. It allows students to be creative and express themselves. I think these are huge accomplishments for middle school students. The problem is once they get to high school they should be able to move onto higher level applications and for the most part they don't.

Queen indicated that she believed most teachers really didn't understand how to integrate technology into instruction. While she made sure students could use productivity software beyond a basic level, she felt some teachers on her grade level did not use technology at all, even though there were technology related goals in the school plan. According to Queen, teachers who felt comfortable with technology used it. Queen felt that without some type of accountability system to make sure teachers integrated the technology into their classroom instruction, many teachers would not use it. There were no rewards for teachers who used the technology. The lack of technology used in instruction did not result in a teacher receiving a lower evaluation. Queen stated

> I do not fault teachers for not using technology in their classrooms. First of all we have no district accountability system and secondly, we don't have the type of intensive professional learning I think we need. We do have a learning technology specialist who works with us at the school level. Her job is to help us use technology effectively in our classrooms. But she normally works with people like me who express an interest in using

technology. She helps me prepare lessons and gives me ideas. Our current specialist has told me that she tries to get as many teachers as possible to use technology but some just will not and there is nothing she can do.

Queen's Classroom Observation

The researcher observed evidence of Queen's beliefs about science teaching and learning on a visit to her class. During the visit a lesson on electricity was observed. The lesson started when students were asked to individually write down what they knew about electricity and how batteries worked. They were then told to share the information with other members of their group. Each group had a "spokesperson" who spoke for the group. There were seven groups of four in the room. Each group was asked to pick one thing they knew about electricity. Queen wrote these down on a large piece of butcher paper labeled "what we know about electricity." She then asked them to share one more things they knew about electricity and she added this to the list. Queen asked each group to come up with one thing they wanted to know about electricity. She then wrote these down on another sheet of paper "what we want to know about electricity." Each group in Queen's room was given a "D" battery some alligator clips and a flashlight bulb and told they should try and get the bulb to light. She also had electrical tape available in case students wanted to use it. All groups were able to light the bulb after about fifteen minutes. During the lesson, students in groups who finished before other groups got up and observed other groups. Many wanted to tell the other groups what to do but Queen who was walking around the room would not allow students to do so. Instead she encouraged each group to continue and provided motivating statements such as "come on, I know you all can do this." The atmosphere in the room was very relaxed. The class ended with Queen asking students to explain in their science journals why they thought the bulb lit.

After the lesson, which was observed prior to her planning time, Queen discussed the lesson with the researcher. She indicated she was using the standards-based 5E instructional model (see Appendix F) to guide her instruction. She first activated the student's prior knowledge using the KWL strategy (see Appendix F) and then used the battery activity to engage students as outlined in the 5E model. The following day she planned on having students share their journal explanations, show a 10-minute video from You Tube about electrical circuits and then explore series and parallel circuits. The researcher was unable to attend the next class due to her schedule.

Case 2: Lucy Line

Pre-teaching experiences. This section describes the pre-teaching experiences of Case 2: Lucy Line. It also identifies people she encountered on her way to becoming a middle grades science teacher. Lucy Line's professional journey map depicting her experiences and people encountered is located in Appendix E. Lucy Line is referred to as Lucy throughout the remainder of the study.

At the time the study took place Lucy taught five sections of earth science at the sixth grade level at School A. She had been teaching at the school for nine years and had taught both mathematics and science. She was in her second year of teaching earth science. This was the first science subject she had taught. Her influential experiences with science began when she was assigned to teach science. Lucy did not want to share a lot of personal details about her life. This is her story.

Lucy began life in a midsized southeastern city in a home that she relates to a heart because it was "a loving home." "It was a small house, a blue house, a beautiful place." Her mother was a housewife. Lucy indicated that her father worked at various jobs. She identified herself as coming from a working class home. She had one brother. She states: “My brother always studied. He read encyclopedias. Today he is a doctor. He attended undergraduate and medical school on academic scholarships. My brother did well.”

She didn’t have much to say about her elementary, middle, and high school years. She says she did well in school but didn’t have any teachers who really motivated or encouraged her. Her motivation came from home and her brother was and continues to be a role model. Her experience with science was limited. She recalls, “In most of my science classes we just read from the book and answered questions. We may have done more but I honestly have no real memories of science.”

She saw her life as a series of decisions. The brain in her drawing represents these. She attended a small historically black college not too far from where she grew up. She decided to major in mathematics because it was always her favorite subject and she wanted to use her brain the way her brother did. She stated that she liked the order and patterns she saw in mathematics. Her love of mathematics is depicted in her drawing by geometric figures and numbers. She took one year of a general science course. “It was an overview of all the sciences but didn’t include the lab.” She also took one semester of general biology and one semester of chemistry. She feels she had some background knowledge in science but didn’t learn how to “do” science.

After college she moved to the large southeastern city and worked in corporate America for a retail-banking firm. She volunteered for a company outreach program where employees tutored school children. As a result of her participation she met a “phenomenal teacher” who allowed Lucy to do many things in her classroom including teaching her class. This is when she thought, “Yes you want to be a teacher.” She also met an influential student; “a very good kid” who had problems in her other classes but did well in structured classroom environments that allowed her to develop. "It occurred to me then that there must be structure." The door in her diagram represents a door of opportunity and money for the influential student "if she can make it." Arrows in all directions represent children in a school who don't know which way to go. She knew she wanted to work with students like this "to help them open that door to learning and opportunity." She enrolled in a special program to obtain alternative certification. When she finished her program, the teacher who influenced her decision to become a teacher had been appointed as the assistant principal at the school where she now teaches. The assistant principal, Ms. R. asked her if she would like to teach mathematics at the school and "I have been here ever since." Although her original plan was to only teach mathematics she was asked the previous year to teach earth science. Because of her college coursework, she has an endorsement in middle grades science.

Table 4.2 summarizes Lucy Line's pre-teaching experiences and people encountered. Family members, particularly her brother encouraged her to attend college. She entered the teaching profession after encountering an influential teacher during a volunteer corporate outreach program with the intent of teaching mathematics. However, due to a shortage of science teachers in her school she was asked to teach science because she possessed minimal college course requirements in science.

Lucy's Key Science Teaching and Learning Beliefs and Experiences.

This section describes the key science teaching and learning beliefs and experiences communicated by Lucy during the research study. Lucy's findings were compiled from interviews, classroom observations and documents she provided. Lucy began teaching science the year before the study took place. She indicated she was told that she must use inquiry-based teaching and learning practices in her classroom and was required to attend the summer professional development academy as discussed in the previous chapter.

Table 4.2

Lucy's Influential Pre-Teaching Experiences and People Encountered

Case	Family Environment	People External to Family Unit	School Experiences	Other Life Experiences
Lucy Line	• Both parents present • mother did not work outside the home • working class • Siblings attended college • Supportive towards achievement in education	• None identified in K-12 or college • Encouraging teacher she met as an adult through her involvement in a job-related volunteer program	• None identified in K-12 or college	• Corporate K-12 outreach volunteer mathematics tutoring program

Beliefs about the Roles of Science Teachers

Lucy believed her role as a science teacher was to teach students how to think critically. She defined critical thinking as being able to "see deeper meanings and not accept explanations of events at face value." According to Lucy

> Scientists constantly dig and dig and conduct experiment after experiment to look for deeper meanings and explanations about phenomena. I really think that some television shows, like CSI (Crime Scene Investigation, a popular show on the CBS network) have done a better job than we have in education to make students understand how important it is to search for deeper meanings behind certain occurrences and to understand that initial

> explanations are not always the correct ones. Of course, I'm not sure all of the science they do on the show is correct but it has made my students aware of how important it is for science to contribute to creating deeper understandings of phenomena and events. I also want them to critically think about things they encounter in their lives.

Lucy also believed her role as a science teacher extended beyond the classroom. She directed an afterschool program for students focusing on character building and service to the community. Lucy explained

> For many of my students, teachers in this building are the only college educated people they come in contact with on a regular basis. Therefore, I must always act in a way and say things that will want them to be like me. They have so many negative role models. For some reason, these role models have become cool. Gangster rappers, women in videos, even some criminals. That life is romanticized. So, we do many things that expose our students to successful African Americans in science, engineering and business. We have people from colleges and universities come in all the time to tutor and interact with or students. We have job shadowing, visits to work places, and a college tour. Our school has an after school program so students can get extra help. I work in the after school program because I believe that teaching here has to extend beyond the regular classroom. I believe I have to show my students I care about them. They have to know that someone is on their side and that teaching is not just a job.

Inquiry and the scientific method. Lucy identified three major instructional practices she utilized: inquiry, the scientific method, and the use of computers. She was in her second year of teaching earth science when the data for the study was being collected. During the summer of 2006, Lucy indicated she attended the summer science academy sponsored by the National

Science Foundation and the school district. During the academy Lucy indicated she learned how to use inquiry-based practices in the science classroom. She characterized inquiry-based learning as having the following components: the use of real-world or authentic problems, the use of students' prior knowledge, the use of questions, and giving students opportunities to communicate their findings. Lucy believed that inquiry allowed students to make predictions and explore concepts they were interested in. She indicated the workshop she attended fostered her belief in inquiry-based approaches to teaching and learning science. Lucy stated

> The workshop helped me realize that I must transform my science teaching because students can learn better if I used inquiry-based approaches. It is not necessary for me to always stand up and teach, teach, teach. I consider inquiry practices ones that I can use to allow students to take responsibility for their learning. Until that workshop I did not consider myself a science teacher. I was teaching like a traditional teacher teaching any subject. I'd lecture and give quizzes. There was no evidence of inquiry-based teaching. I didn't even try to do experiments of any kind.

According to Lucy, the district-sponsored workshop focused on the use of the 5E model (see Appendix F) and using formative assessment probes to activate students' prior knowledge and find out what students' misconceptions about science concepts were. Lucy indicated that formative assessment probes are quick assessments given to students to provide information to the teacher about student understanding of concepts before they are taught. She gave an example of a formative assessment probe she used to support inquiry-based teaching in her classroom. She stated

> I ask students to respond to some questions related to the topic I'm going to teach on a blank sheet of paper. Students ball up the paper and toss it somewhere in the room.

> Students then go around and pick up one of the crumbled – up responses, take it back to their group and try and to explain the response to the other members of their group. This method gives students opportunities to explain what they know about a topic using a "low risk" method and see what other members of their class think. We share some of the responses out load. I collect the responses to give me an idea of what they are thinking. It helps me know what they already understand and what their misconceptions are. I don't have to give a pre-test or grade anything. These formative assessment methods have really helped me as I work to become a better science teacher.

At the time the study took place, Lucy indicated that while she had used some inquiry-based strategies, she did not consider herself an inquiry-based teacher. She indicated that she was in the very early phases of transforming her teaching. She maintained she did not use inquiry-based approaches as much as she would have like to because she did not have extensive content knowledge. Lucy indicated

> I have minimal preparation in science and have had no earth science courses at all. While I do read the text ahead of the students and use various internet resources to get background information, I do not know the content the way a person with extensive coursework in it would. While I have the minimum requirements for an endorsement in middle grades science teaching I never thought I would ever be expected to teach it. But now that I am I feel I owe it to my students to learn as much as possible so I can be a good science teacher. I want my students to have a positive experience with science. I just don't feel they can unless I learn about the topic.

Lucy taught math prior to science and she considered herself a math teacher learning how to teach science. She indicated that she was given the choice of teaching science or leaving the school. The enrollment in the school dropped and only two math teachers were required on her grade level. There were no other openings for math teachers at the school but there was a science vacancy. Lucy agreed to teach science when offered in order to stay at the school. Lucy indicated

> I am a single parent. I live in this neighborhood and my daughter attends the local high school. Because I teach here, I am able to drop-off and pick-up my daughter from school. If she gets sick in school, I am not very far away; it's very convenient personally, so I am willing to adjust my professional life. It has been a challenge though.

Lucy reported that she used the textbook as her major resource to guide instruction and used experiments and worksheets that came with her text. Lucy stated

> As someone who is still learning how to teach science, my textbook has been a valuable resource. It helps me to plan and organize my lessons. The worksheets, transparencies and web resources provided by the publisher give me materials to help make my lessons interesting. Without it, I would have no idea how to structure a lesson. In my opinion publishers have done a good job in creating textbooks and other resources. With professional development, I am developing an understanding of inquiry-based teaching and learning. Without it I would be lost. I have some interactions with the other science teacher but we do not plan our lesson together. That's why I was glad to meet other teachers this past summer. We do communicate by email and share ideas.

Lucy also mentioned the use of the scientific method in science instruction. Lucy indicated she used the scientific method as outlined by her textbook. Lucy indicated that she was aware that some educators viewed the scientific method as being too linear and just "cook book" science. She stated

> Unfortunately, science is taught so much like language arts and through reading that I believe many students are not used to formulating opinions or asking questions. They are not used to experimentation so I use the scientific method to help them to get comfortable with working through a science lab. It also helps me to review safety practices. However, students can't seem to understand that a hypothesis does not have to be correct. Some even have trouble forming a hypothesis because they don't have enough background knowledge. I ask students to formulate a hypothesis in the sense that they must attempt to tell me what they think the outcome of an experiment might be. Sometimes they have no idea and that's OK too. But I at least want them to think about it prior to beginning an experiment. So I guess my version of the scientific method is less structured than it is supposed to be. I also want to make it clear that although I have limited experience teaching science and limited experience with inquiry-based science teaching, I believe the use of inquiry-based approaches does not mean that methods like the scientific method should never be used. Inquiry also means the use of many methods that encourage students to formulate questions and draw conclusions based on data and I think my use of the scientific method does that.

Beliefs About and Experiences with Computer Technologies

Lucy was a proponent of the use of computer technologies in science instruction. She stated

> Before I began teaching, I worked in the banking industry. The use of computers has been an integral part of the banking industry for many years. Of courses, computers were regularly used for transactions, but in my position I used computer software to track data and prepare financial reports. I also used the technology to communicate by email with

> my supervisor, who was located in a different area and with others. We used computers for professional development within the industry. So, when I started teaching, I did not fear computers and certainly felt their usage would be a natural part of my teaching. I was really surprised to learn how far behind K12 education was.

When Lucy first started teaching, she reported that she had no classroom computers or Internet access. She indicated that she taught for “about three or four years” before the first computer with Internet access was placed in her classroom. Before she received a classroom computer, Lucy used her personal laptop to teach students how to use productivity software (word processing, presentation, and spreadsheet) by having students work in small groups. She stated, “Frankly, I was waiting for K12 to catch up to me.” She indicated the school now has learning goals for students that emphasize mastery of productivity software and using the Internet to find information and conduct research before they go to high school. However, she indicated there is no encouragement for teachers to implement classroom instructional practices that would help students achieve these goals. Lucy stated

> Teachers who actively use computers and believe students should also use them, use them. I am a technology geek. I love gadgets and using the Internet. I’m in my comfort zone so I’m not afraid to try new things. I regularly communicate with family members by email and we have a family website. Some teachers have not yet mastered computers personally so I think they are not comfortable using them professionally. I am an advocate for the use of computers in science education because I know they are used in the business world and in scientific research. Since I believe part of my role as a teacher is to prepare students for the real world, then I must use computers in my instruction. Yes, it can be challenging and not all my lessons are successful, but I owe it to my

students to help them learn using 21st century strategies. My students are not afraid of learning using computers, so why should I be?

Lucy identified three ways in which she believed computer technologies supported science learning for her students: (1) They allowed her students to easily communicate their findings and ideas about science concepts to others; (2) They encouraged her students to creatively express their understanding of science concepts; and (3) They helped students remember science concepts. Lucy provided an example of how students creatively expressed their understanding of science concepts using the presentation program, PowerPoint. She stated

> Students have been able to report their understandings of concepts using PowerPoint, (presentation software published by Microsoft). They can be creative with pictures, embedded video, fonts, music and format. For example, my students were required to create a PowerPoint presentation on something they learned in earth science during the school year as a final project. They worked in groups of two and were allowed to pick any topic we'd focused on. Two of my students prepared a PowerPoint presentation on the era in which dinosaurs lived, the Mesozoic era. They used pictures from the Internet and photos of dinosaur toys they took using a digital camera. They embedded music and narration using a script they prepared from their research and a video I downloaded from a United Streaming. I did not teach them how to embed music or a video. They went to the media specialist and asked her to show them how to do these things. It was of their own initiative. I was particularly happy to see they credited the resources used on each of their PowerPoint slides. Their last slide thanked all of the people who helped them including one student's little brother who let them borrow his dinosaur toys. It was very creative and informative. The two students became experts on the Mesozoic era while

> preparing the presentation. I also want to mention that they did not have computers at home. They came to school early and worked in the media center and took the late bus home twice a week for four weeks. By giving them choice and an opportunity to be creative using technology, these students became very motivated. These were not two of my best students either. I asked them why the put so much effort into the assignment and they told me it was because they really liked dinosaurs and computers. I taught them for a whole year and had no idea how creative the two of them could be. That's what I like about the use of computers so much. Students are naturally motivated and curious when they utilize technology. I have never had a student who does not want to use a computer. However, I believe better professional learning is necessary. Even though I like technology, I am not familiar with how its most effectively used in science instruction.

Lucy indicated that she believed computers are not yet being consistently or effectively used in classrooms because many teachers are not comfortable with them. She stated

> Our students are not afraid of the technology. To them it's very natural. K12 education is going to have to figure out how to successfully move beyond productivity software and the use of the Internet for research to provide meaningful learning experiences with technology. I read about the use of Second Life, a virtual online world, in education. I'd like to try and use this with my students but our school district is not there yet. We are just beginning to move beyond the basics so hopefully within the next two or three years I can implement a Second Life project in my class. Right now, I am experimenting with Second Life on my own and have created a virtual person or Avatar to help me explore it. Through it I connect with others throughout the world. I am not quite sure how it all works yet because I am in the very early stages of using it myself but I do see its potential

for educational use. Perhaps educational games focusing on science content could be created and students could develop avatars to play the games and learn content at the same time.

Lucy's Classroom Observation

During the observation of her classroom, Lucy taught a lesson focusing on the history of computers. She presented a PowerPoint slideshow she created about the history of computers while students took notes. She then showed a video about computers. Students freely asked questions during the PowerPoint and Lucy answered them. She was very knowledgeable about the history of computers. She indicated she had "picked this information up from somewhere." Her classroom was set up lecture style with rows of flat-top desks. There were twenty six students in the room. Lucy indicated students pulled the desks together when they do "experiments." There were samples of dioramas the students had completed for homework focusing on geologic periods on a few small tables surrounding the room. There were commercial earth science posters on the walls as well as posters about the planets (from a previous unit) made by students. The room is bright with a wall of windows. Lucy has a multimedia projector and TV/DVD in the room. She has one laptop computer and printer for her use and five desktop computers in the room with a networked printer. Each computer has Internet access. The researcher surveyed Lucy's room for earth science equipment and tools used to teach earth science. There were a few items including thermometers, barometers (student made and commercial), graduated cylinders, eight student sets of rock and mineral samples, a few beakers of different sizes and some bags of soil. Otherwise, no evidence of any other earth science materials was present. I asked her if materials were stored in another room or storage area. She indicated they were not. She explained that she uses a lot of everyday items to teach science. For example, when they studied weather the students made barometers from cans they brought in and balloons and straws she purchased. She did not use the school weather center to teach science because she did not know how to use most of the equipment. Lucy indicated she has never used much of the science equipment recommended by her text. For example she has never seen a stream table or conducted a rock analysis using Moh's hardness scale. She was planning on attending a workshop for earth science teachers during the summer offered by Georgia Tech and hoped to learn how to use some of these items. She does not feel comfortable teaching herself. Right now she searches for lessons on the Internet, uses her textbook as a resource, and uses items she can easily find at Wal-Mart. Because she is comfortable with mathematics she looks for activities that incorporate mathematics. She reported that her students collect data, put the data into Excel, a spreadsheet program with graphing capability and graph data using Excel on a regular basis. There was evidence of this in her classroom. Students had just completed the weather unit in January and taken temperature and barometric pressure (using the barometers they made and commercial ones) over a two week period in January. They then constructed graphs (computer generated) comparing temperature and pressure for that two week period. They compared their data with the National Weather Service data. The graphs were hanging on the large bulletin board in the room.

Lucy has also taught her students how to use graphing calculators and then use the calculators to analyze data. Although Lucy thought it was good that she spent time connecting mathematics and science, she indicated that she would like to learn more science so she could apply more inquiry-base strategies in her classroom. She believed it would make her a better science teacher. Lucy stated

> I had enough science in college to be middle school science certified but it really is not my area. I moved from mathematics to science because a certified science teacher was needed and no one else had the certification. Plus, I do really like science. This is only my second year so I have a lot to learn. I plan on participating in as much professional development as possible. Actually, I know more about life science but I'm teaching earth science and that's what I knew very little about before I started teaching it.

Case 3: Zora Walker

Pre-teaching experiences. This section describes the pre-teaching experiences of Case 3: Zora Walker. It also identifies people she encountered on her way to becoming a middle grades science teacher. Zora's' pictorial representation of these experiences and people is located in Appendix D.

Zora taught physical science at the eighth grade level at School B. She had been teaching various schools in the system for twenty six years and had taught all middle school science subjects including earth science, life science, and physical science. Her influential experiences with science learning began in high school. The researcher traced her story past when she started teaching because she did not start teaching in middle schools right away. This is her story.

Zora was born in a large northern city. She is an only child. Her mother wanted her to have the best education possible and sent her to a Catholic grade school and a Catholic high school. In each case she was the only black child in the school. She attended an all girls' Catholic high school. She remembers that her 10th grade biology and 11th grade chemistry teacher, Sister MJ, instilled a "love for science in me." We did lots of labs so I got to really use science tools. I loved the beakers, flasks, microscopes, and all the other science things. Of course dissecting a frog was absolutely the most wonderful experience. I know now that it was pretty basic stuff but I felt like I was Marie Curie. She's the only women scientist I knew. She went on to say,

> Sister MJ told me I could become anything I wanted to be. This was pretty incredible in the late sixties. There were very few women in science, particularly black women. I think Sister MJ was somewhat of a rebel. I know she participated in the civil rights movement including the March on Washington.

Until that time she was unsure of what she would do with her life. Most of her teachers paid little attention to her. She felt it was because "they couldn't relate to a black girl. So, they just ignored me. They were never mean, just indifferent." She took one year of biology and one year of chemistry in high school because that's all the school offered. She stated

> My high school was really setup for wealthy white girls to learn how to be wives and mothers. Since going to college was not expected there weren't many science or math classes. We even had a math class that taught you how to wisely use your household budget. I look back on it now and just laugh. Most of the girls in her graduating class either got married right after high school or stayed at home. "Most were fairly wealthy so they really didn't have to work." She decided she would major in biology in college and become a science teacher. I don't know why I never thought of majoring in science until Sister MJ. My father was always reading science related books and encouraged me to consider science but I just didn't think about it. He was a very smart man. He was really born too soon.

Her father had a chemistry degree from a small black college in the south. But like many other African American men, he was unable to get a job so he "came north" and worked in an auto plant. It was just "understood that I would go to college." My parents saved money to pay for it. "My mother would worked as a maid periodically to help save up."

She majored in biology and education at a historically black college in Tennessee. Her college coursework and extracurricular experiences confirmed her career choice. She was able to take introductory biology, zoology, microbiology, chemistry including organic chemistry and physics. She volunteered as a tutor at a local school. She stated

> I threw myself into science and science education. Dr. M., my biology professor encouraged me in my career choice and introduced me to black teachers and administrators. Up until college I had no black teachers and except for Sister MJ no one except my family to encourage me.

After college she married a doctor ten years her senior and began teaching high school biology in a large Midwestern system in 1975. My husband was the brother of my college roommate. I met him when I went to their home during one of our breaks. We dated long distance for four years and were married as soon as school was over by a justice of the peace. I didn't want my parents to spend money on a big wedding. She earned a masters degree in Curriculum and Instruction. Her mother died and then her father. Her husband died unexpectedly after five years of marriage. In search of a new life she moved to the large southern city where this study took place. She knew her parents would have thought "she was crazy." According to Zora, they'd both left Mississippi at early ages to escape Jim Crow and never wanted her to live there permanently. "College was fine because they I knew I was relatively isolated and safe." But she felt the south was changing and many of her sorority sisters had moved to the large southern city where this study took place. She felt her "sorors" would provide a support network. She is a member of an African American sorority. "The sorors are like my sisters." Although she had taught high school up to that point she decided to try middle school life science since she felt she could "mold and shape" the younger students.

Table 4.3 summarizes Zora's individual pre-teaching experiences and people encountered. Family and supportive non-family members at the pre-college and college levels encouraged her to become a science teacher. Experiences with a supportive high school science teacher were very influential in her choice to become a science teacher. She also encountered college faculty who supported her career choice.

Table 4.3

Zora's Influential Pre-Teaching Experiences and People Encountered

Case	Family Environment	People External to Family Unit	School Experiences	Other Life Experiences
Zora Walker	• Both parents present • mother worked outside of home on a periodic basis • working class • Supportive towards achievement in education	• high school science teacher science content knowledge • high school science teacher as advocate for academic achievement • college faculty member as advocate for science teaching career • sorority sisters provide support	• Limited high school science coursework • Introduced to science tools in high school • College major in biology - extensive science coursework • Extensive coursework as high school and undergraduate • Master's degree in Curriculum and Instruction	• Move to southeastern state due to deaths in family

Zora's Key Science Teaching and Learning Beliefs and Experiences

This section describes the key science teaching and learning beliefs and experiences communicated by Zora during the research study. Zora's findings were compiled from her interviews, her classroom observations and documents she provided. Like Queen, Zora participated in several district sponsored professional development science education reform initiatives as discussed in the previous chapter. Zora indicated that she learned about implementing inquiry-based instructional practices in her classroom as a result of attending these workshops and as a result of her membership in the National Science Teachers Association (NSTA). Zora stated that she had attended all NSTA conferences for over 15 years. Like Queen, many of Zora's interview responses focused on inquiry-based teaching and learning.

Beliefs about the Roles of Science Teachers

Zora identified classroom and non-classroom roles of science teachers. For Zora, the roles of science teachers focused on creating critical thinker and problem solvers who would use their knowledge of science to improve society. She stated

> My role as a science teacher is to help students know how our world functions scientifically and to use science to make our world a better place. They need to know why things happen so that they can learn how to live better. For example, approximately six students came to our school after Hurricane Katrina from the 9th Ward area of New Orleans. That neighborhood was destroyed. When I asked them did they really understand what happened they couldn't tell me? They couldn't scientifically explain the causes of a hurricane or the engineering that would have told them the levees were not built to withstand massive flooding. Many of the students' families lived in the same area for generations. They lived in a neighborhood, which eventually, because of nature and

> poor engineering would have been destroyed eventually. The students had no understandings about what really happened. It is my responsibility as a teacher to help students know how to build understandings.

Zora believed another major role of a science educator was to help students become critical thinkers and problem solvers in the context of real-world problems needing solutions. She stated

> Science is the gatekeeper subject when it comes to problem solving and critical thinking. Figuring out how long it takes a train to get down a track won't help us solve the problem of hunger in Africa or cure AIDS. There's no context. Problems have to be put into a context that students can connect to. The challenge for mathematics and science teachers is figuring out how to create meaningful lessons between subjects so that students can solve scientific problems mathematically or use math as a tool so that students will learn how to think critically on both a global and on a micro level.

The researcher asked her to clarify what she meant by on a global and on a micro level and she responded

> I mean science education should help students analyze the big picture by dissecting it to find out what‘s there. It should them ask thought- provoking questions to help then figure out the why behind the why. For example, I once read about a flood that took place on an island, I think Honduras. Hundreds were killed in an area where no one had been killed in previous floods. I wondered why. The news made it sound like it was because of the heavy rain. But I knew there must have been other factors so I did some research and found out the people living in the area had been forced to move there because the government was selling their ancestral homelands to a certain US corporation to grow cheap potatoes. And the new place they were forced to move to was in a flood plain. So

> the real reason for the deaths was not due to the flood but to the government's desire to make money. That's what I learned from science, how to pick a problem apart to get at the core, the center and that's what I believe one of the main roles of science education should be. Only then when you know the core problem do you know the true problem. Then you can find a solution that works. It's imperative that we use real-world problems in our classrooms so our students can practice becoming problem solvers.

Zora indicated that she believed African American teachers had the responsibility to "give back" to the African American community and should therefore teach in predominantly African American districts. She stated

> When I first came to Georgia, I was asked to teach in a suburban district. At the time the district was predominantly white. I decided to teach in the city because I felt I had a responsibility to give back to the African American community. Although I was not wealthy as a child, I know that I was relatively privileged compared to my students. I wanted them to see a successful black woman who encouraged them to be successful too. I am a role model. I have been in the profession long enough to see some of my students pattern themselves after me. How do I know this? They have told me. They come to see me or I meet them all over the place. This past summer a former student came up to me at the workshop I was attending. She asked if I remembered her. I did. She explained that she is now a middle school science teacher at another school in this district. She thanked me for being so kind and motivating her to become a science teacher. I hadn't seen her in over eight years but she still remembered me and my classroom. This student grew up raised by a grandmother in public housing. So when I see my students become

> contributing members of society, particularly students who had difficult upbringings, I know I have made a difference by teaching in this community.

Zora wanted to make sure the researcher included her statements about the devotion to African American students she believed everyone at her school had. She, like Queen, was troubled that not enough African American teachers were depicted in the media as positive role models or good teachers. She stated

> I've been at this a long time. Our school, like so many others, has all kinds of extracurricular activities for students. We have a group for our girls that we hope will teach them how to be independent thinking your women. We have the same group for our boys. On many days students don't leave this building until after 5PM. We pay for late busses out of the school budget so children can stay late for different activities. We have Saturday programs. We do all kinds of things that we think will help these students become successful contributing members of society. Although I didn't need this type of motivation when I was growing up these students do. The majority of the staff in this school is African American from the principal on down. We are committed to these children. Please make sure you include what I just said in your paper. If people begin to read some positive things about African American teachers other than Marva Collins who incidentally hated public education, perhaps someone will be motivated enough to make a movie about us (African American teachers).

Inquiry. Zora indicated that she uses inquiry-based instruction as the major instructional approach in her classroom. According to Zora inquiry-based instruction involves the use of questions to help students formulate ideas, make observations, conduct investigations, and communicate results. Zora indicated inquiry-based instruction is characterized by the use of open-ended questions to help students solve real-world or “authentic “problems. Zora indicated that she believed the using inquiry-based approaches emulated the work of real scientists. She stated

> For me, using inquiry means that I am expected to ask students more questions in order for them to develop their critical thinking skills. I don’t stand-up and tell them everything, which they then mostly try and memorize and remember for the test and then we move on. I organize my instruction so that I can elicit information about what they know, alleviate any misconceptions they may have and then move on from there. I ask students to explain their thinking to me. For example, when we study surface tension I use an activity with milk, dish detergent and food coloring, which results in bursts of color. Instead of telling them what is happening, I ask the students to explain it to me. I allow them to conduct Internet research and draw conclusions based on their research and observations. They actually have lots of explanations that may not involve surface tension at all. This activity has been around a long time. However, in the past I might have introduced some concepts first and then completed the activity without feedback from my students. Afterwards, I would have explained it all in a lecture. Now I build on their conclusions and guide the instruction. I once heard someone say inquiry is just good teaching and I agree with that.

The researcher asked Zora if she used inquiry as the major classroom instructional approach because district administration promoted its use. She indicated that she used it because she believed it matched her constructivist philosophy of teaching and learning. She stated

> I am a believer in constructivism. I do believe, like Vygotsky, that students construct knowledge through social interaction. That's why I try to use inquiry-based practice as much as possible. I use cooperative learning and have been for about 20 years.

Zora indicated her transition to being comfortable using inquiry-based instructional approaches was gradual. She attended professional development workshops, Georgia Science Teachers Association and National Science Teachers Association conferences and practiced various aspects of inquiry-based approaches with her students. At the time the study took place Zora reported that she supported other science teachers in her school and helped them integrate inquiry-based strategies. Zora had also been offered district-level Model Teacher Leader (MTL) positions. Part of her responsibility would be to help other science teachers across the district integrate inquiry-base instructional practices. Although Zora had turned the offers down on many occasions, she made the decision to accept the last offer. She planned on leaving the school at the end of the school year. She stated

> I was honored to be recognized by others as someone who can help teachers change their teaching practice. I have a few more years until I'm eligible to retire so I'd like to try something different. I also think I can impact more students in the district by taking the position.

Instructional models. Zora believed the BSCS 5E Model (see Appendix F) was helpful in giving teachers a guide for instructional planning and implementation. She indicated that she has been a member of the National Science Teachers Association for over 20 years. She stated

> I have been using some type of instructional model to guide my instruction for years. I am a firm believer in an organized classroom and that means organizing my lessons too. I used to use a model call SCIS. I don't remember what the acronym stood for but it was

> very similar to BSCS in that it had certain steps to follow. In the first step students had opportunities to explore concepts before they were formally introduced. For example, in a unit on sound I used to teach, I'd put out a variety of common materials on a table: boxes, sticks, bells, all kinds of things. I asked students to create instruments using the materials. The students would demonstrate their instruments and I'd ask them questions about why they were able to hear the sounds made by the instruments. This would allow me see what they already knew about the concept. I'd then introduce vocabulary related to the concept through lectures; students might do some research in the library and watch a video focusing on the topic. In the final step, I'd have them have them do some type of formal experiment or in most cases more than one to further their understanding of the topic. So, when I first read about the 5E model some years ago, I started using it and it worked for me so I continued to apply it in my instruction.

Zora believed the use of inquiry-based approaches is motivational for students but has some reservations about its use in classrooms that are poorly managed. She stated

> The idea of "doing science" is extremely motivational for our students. But without good management strategies, the classroom would collapse and chaos would result. With good management you can control the chaos. I spend the first week of school teaching my students how to work together in groups and what my expectations are. They know they won't get a chance to do anything unless they meet my expectations. I have rarely met a student who didn't want to do experiments but you have to really teach them how. Students need to be clear about what is expected.

Traditional approaches. Zora also expressed her belief that using traditional instructional approaches was acceptable in some instances, particularly when teachers teaching science do not have a science background. She explained

> The new Georgia Performance Standards require that teachers have a really deep understanding of content. Without that, I'm not sure that teachers with little content knowledge can use inquiry successfully. That's why I don't think it's all wrong to use traditional methods. By traditional, I mean the use of what some call cookbook based labs. Cookbook labs are where students follow a detailed set of instructions. Many teachers at the middle school level do not have deep content knowledge or true science backgrounds. They don't have the experience or knowledge to successfully teach using inquiry-based practices without a lot of in-class support. They really need the textbook as a guide. I certainly think it's better to use the textbook as a guide and do the recommended labs and activities the way they are written than nothing at all. I've seen teachers teach science by having students outline chapters, answer chapter questions, define vocabulary words and take a written multiple choice test. Students never get an opportunity to do any hands-on science. So, while cookbook science experiences may not be inquiry-based, students will at least have an opportunity to experience some science. However, teachers should seek to improve their knowledge and increase their comfort level as quickly as possible and seek to create inquiry-based classrooms. If they cannot within one or two years after beginning to teach science, then they should move on and teach something else or leave the profession.

Beliefs About and Experiences with Computer Technologies

According to Zora, she has been a proponent of the use of computers in instruction for over twenty years. She explained

> I think science teachers are naturally curious about anything new. We are used to experimentation. So when computers were first introduced I saw them as an experiment. My experiment focused on introducing a new piece of technology in the classroom that I hoped would excite my students about learning. I didn't care about whether there were programs available to teach science or not. At the time the emphasis was on the use of the technology to motivate my students.

Zora was able to provide a historical overview of her use of computers in education. She stated

> I started using computers with students when the Apple II was introduced back in the 80s. Our school participated in a special program and we received IIs for use in our school. Since I expressed the most desire to actually use them as part of my classroom instruction, I was given all five of them to use. We did processing using Apple Writer or Apple Works. My students would create small programs using a programming language called BASIC. In fact textbooks used to have BASIC programs in them that students could type in. Many of the programs could perform simple mathematical operations like adding a series of numbers. We had another language called LOGO that had this little triangle called a turtle that students could program to move around the screen. In the early days, students were just as motivated as they are now. I knew then that computers were something we needed in the classroom. There was no data that told me this at the time. But I saw how motivated and interested the students were so I knew how important computers could become. Of course, there was no Internet, just keyboarding, drill and

practice, and simple programming. Those things don't seem that exciting when we look at what we have now but it was so thrilling for my students at the time. Computers were new and totally different from anything we'd ever seen. At the time, I never imagined what we have now.

Zora described three early software games that she used in her classroom. According to Zora, these games were fun and helped students learn new concepts. She stated

> Although the early games I used in my classroom were not focused on science, I felt it was necessary to incorporate them into my instruction in order to keep my students interested in learning. I'd often use them as a way to reward my students for good work in science. There were three games that my students absolutely loved: Oregon Trail, Number Munchers and Where in the World is Carmen Sandiego? Number Munchers was particularly good because it helped students review math concepts. Students used a character called Muncher to eat numbers that fit a mathematics rule like the factors of three or prime numbers while avoiding a monster called a Toggle. Where in the World is Carmen Sandiego? was also very popular. The object was to figure out where a detective, Carmen Sandiego, was as she tracked criminals around the globe. It was great in helping students learn geography. Oregon Trail's premise was based on traveling the route of the Oregon Trail without dying from some disease like dysentery. In addition to learning geography and history, I'd have students go to the library research various diseases and prepare reports. I'd really thought gaming and computer simulations were going to be change the way students learn, including science. However, I have not seen it being transferred into classrooms. I think the popularity of video games as entertainment, eclipsed the educational use of games.

Zora reported that she focused on using productivity software; word processing for reports, presentation software for student presentations and spreadsheet software for graphs and charts. She also indicated that her students used the Internet to research information and to construct atoms or demonstrate motions and force concepts using web-base simulations.

Zora indicated three major ways she thinks using computer technologies contributes to student learning: (1) Expands the amount of relevant up-to-date information students have access to; (2) Increases their ability to express their thoughts and opinions on various topics; and (3) Increases their ability to communicate with others outside of their general neighborhood.

Zora's Classroom Observations

The researcher observed Zora's classroom on two occasions. During the first observation, Zora used the KWL strategy to engage students. According to the North Central Regional Educational Laboratory (2007)

> Teachers activate students' prior knowledge by asking them what they already know; then students (collaborating as a classroom unit or within small groups) set goals specifying what they want to learn; and after reading or completing an activity students discuss what they have learned. Students apply higher-order thinking strategies which help them construct meaning from what they read and help them monitor their progress toward their goals.

Students were asked to individually write down what they knew about electricity and how batteries worked. They then shared the information within their small group of four.

Each group had a "captain" who spoke for the group. There were five groups of four. Each group was asked to share one thing they knew about electricity. Zora, like Queen wrote these down on a large piece of butcher paper labeled "what we know about electricity." They repeated the question once more. Zora also asked each group to come up with one thing they wanted to know about electricity and then wrote these down on another sheet of paper "what we want to know about electricity." In Zora's room students were given the flashlight bulb, some alligator clips, a lemon, and a penny and told to light the bulb.

The atmosphere in Zora's room was much the same as in Queen's. No group was able to get the battery lighted after about 10 minutes. Each group unsuccessfully tried different strategies which Zora encouraged. After ten minutes when a couple of groups had given up Zora stopped the class and showed a video she had downloaded from You Tube on how to make a lemon battery. Class ended but Zora told students they would continue with the lesson tomorrow and that each group could try again.

Zora's classroom was built as a science lab when her school was remodeled five years ago. The room was very large with a lab table with two sinks on one side and a lab table with another sink up front. She had eight lab tables with four chairs per table for students to sit at. She had ample storage for equipment including cabinets with glass doors on the walls with more storage. She also had a large storage room next to her classroom with an additional sink. The school was designed to have three labs at each grade level connected to each other by this storage room. However, due to low enrollment there was only one science teacher per grade level and the storeroom had been partitioned off so that Zora shared it with the social studies and language arts teachers at her grade level. Zora indicated that due to "gentrification" the apartments where many of her students came from had been razed to create single family housing starting at $380,000.00. She thought many of the people in the new houses were young couples without children or with very young children. "Our current population is made up of students living in the single family homes that were already here. Many are renters and the homes are in poor condition. I'm not sure what will happen with this school in the future." Although Zora's classroom was large, it was also dark. There were no windows to the outside in any classroom in the entire school. Some of the outer classrooms had small slits at the top of the outer wall near the ceiling to let light in. Zora had purchased extra lighting for the room out of her own funds. The room was painted bright orange to "give it a cheery atmosphere." There were no bulletin boards in the room but Zora taped student work on one large wall. At the time the study took place student work from an experiment they conducted during the force, motion, and acceleration unit was taped to the wall. Students designed and created mousetrap cars. Each group of two had the freedom to experiment with various designs. They measured the distance traveled, the speed (using a light meter), and graphed (computer generated) the results. Zora had ample physical science materials. Her principal was a former science teacher and Zora indicated that he allowed the science teachers to order whatever they need. They were also able to purchase items from stores like Wal-Mart and get reimbursed when they turned in a receipt and copy of the activity. Zora indicated it was easier to teach science in the school because the principal understood that science teachers needed equipment.

Zora had a laptop and printer. The school was wireless so she was able to get Internet access. She had six desktops with a networked printer for student use. She also had a ceiling mounted multimedia projector. She was able to connect her laptop to a presentation station that also had a DVD player.

I was able to observe Zora a second time. It was three weeks before the end of the school year. Zora calls this unit her "big finish" to the end of the school year. It focuses on flight and spaceflight. The unit was actually given to her as part of a professional learning program the researcher designed and taught. Zora was in the program about five years ago but has been using the unit, with her modifications ever since. The day I observed, Zora was beginning the unit with a History of Flight Timeline PowerPoint presentation. The timeline traced flight in pictures and words from Egyptian mythology through the present day. It includes milestones in flight and also targets African American achievements in flight. She began by using the KWL strategy to engage students. She then went through the PowerPoint slide by slide and traced the history of flight. Students asked questions and Zora called on the researcher to answer some of these. In our discussion of the lesson afterwards, Zora explained that she uses the PowerPoint to further engage her students in the lesson.

Cross-Case Findings

The previous sections presented with-in case findings of each participant. This section presents and summarizes the findings of the cross-case analysis of the data collected from the participants. The research questions and conceptual framework guiding this study serve as the organizing context for this section. While the previous sections focused on the individual, this section focuses on the participants as a collective group. The section is divided into two sub-sections: (1) Collective Pre-teaching Experiences and Influential People; and (2) Collective Science Teaching and Learning Beliefs. Data displays are also used to summarize collective findings, collective pre-teaching experiences, and influential people.

Table 4.4 provides a synopsis of each participant's critical pre-teaching experiences and influential people encountered. Queen and Zora encountered people at the pre-college and college levels who encouraged them to become science teachers and motivated them to do well in science. They both had positive pre-college experiences with science. In addition to being motivational these experiences provided opportunities to use science equipment and see science in action. Queen's experiences were extensive beginning in middle school. Teachers knew of

Table 4.4

Collective Influential Pre-Teaching Experiences and People Encountered

Case	Family Environment	People External to Family Unit	School Experiences	Other Life Experiences
Queenlateacher	• Both parents present • mother did not work outside the home • middle class • Siblings attended college • Supportive towards achievement in education	• elementary and middle school teachers as motivators towards educational achievement • high school teachers as motivators for educational achievement • college faculty member as advocate for science teaching career	• Science related field trips at the elementary and middle school levels • Summer science programs at West Point and Andover Prep • High school level participation in science contests • Extensive high school coursework in science and mathematics • College major in biology with education minor • Student teaching in college	• None identified
Lucy Line	• Both parents present • mother did not work outside the home • working class • Siblings attended college • Supportive towards achievement in education	• None identified in K-12 or college • Encouraging teacher she met as an adult through her involvement in a job-related volunteer program	• None identified in K-12 or college	• Corporate K-12 outreach volunteer mathematics tutoring program

Table 4.4 *(continued)*

Case	Family Environment	People External to Family Unit	School Experiences	Other Life Experiences
Zora Walker	• Both parents present • mother worked outside of home on a periodic basis • working class • Supportive towards achievement in education	• high school science teacher science content knowledge • high school science teacher as advocate for academic achievement • college faculty member as advocate for science teaching career • sorority sisters provide support	• Limited high school science coursework • Introduced to science tools in high school • College major in biology - extensive science coursework • Extensive coursework as high school and undergraduate • Master's degree in Curriculum and Instruction	• Move to southeastern state due to deaths in family

her interest in science and made sure she was able to participate in science-related experiences outside of school. They believed she could be successful in science and she did well. While Zora's pre-college science experiences were not as extensive as Queen's, she also had opportunities to use science equipment and conduct science experiments. Queen and Zora were confident in their abilities to be successful in science courses. Both selected science majors in college and felt well-prepared to enter the science teaching profession. Lucy's pre-college and college experiences in science were not particularly memorable or motivational. Unlike Queen and Zora, she had no teachers or school experiences that encouraged her to excel in science.

All participants came from intact two parent families where education was valued and encouraged. Intellectual pursuits, reading by Zora's father and studying by Lucy's brother for example, were evident in the participants' homes. Each participant came from relatively middle class families, particularly for African Americans. Zora's father had a degree in chemistry but was unable to find opportunities in the profession primarily due to his race. Queen's father, while not college educated, possessed a special skill that placed him at the top of his profession.

All participants attended a historically black college or university (HBCU). The researcher asked each about their choice. While Queen and Lucy indicated they could have chosen a majority institution, they both wanted the "black college" experience. Queen stated

> I wanted to have a full academic and social life. I knew that if I went somewhere else I would be part of a small group and I just didn't want to deal with that. My older brother and sister chose to go to majority institutions and they advised me against it. They were the only black person in many of their classes. Although they stuck it they felt isolated much of the time. The white students did not include them in social events. My sister's freshman roommate left after two days because her parents did not want her to share a room with my sister. She spent the first month in the room by herself. A black roommate who had been tripled in a room with two white girls was finally put in the room with my sister. She didn't ask to leave her room but the decision was made at a higher level. My sister and her roommate are still friends. I just didn't want take a chance that I might have to deal with racial issues.

Lucy indicated

> My brother advised me to go to a black college as he had done. He wanted me to make lifelong friends and be better prepared for the world I would encounter. He did not think I was mature enough to deal with some of the racism he encountered in medical school.

> We'd been isolated because we lived and went to school in an all black community. He was correct. Many of my college friends are still my good friends.

For Zora there was no other choice but a HBCU. "I'd spent my entire academic career up to that point being the one (the only black person). I was not going to go through that in college."

The researcher asked Zora and Queen, because of the paths they took to become science teachers, if race and/or gender of influential science teachers impacted their decision to become a science teacher. Queen indicated that although she was aware of the person's race and gender, her career decisions were not directly impacted by them. According to Queen

> My teachers were mostly black and mostly female before I entered college. I saw them simply as successful teachers. I didn't really think about their race or gender. Being a female teacher was just a normal thing. I had one white male teacher in high school, Mr. B. I do remember that I thought he was "cool" because he supported us and didn't treat us poorly just because we were black. He was just like all of my other teachers.

Zora indicated that her high school science teacher's gender and race did impact her. She stated

> Because of NASA's landing on the moon in 1968, I knew about astronauts. But other than that I was unaware of any famous scientists at that time. I had read biographies of Marie Curie, Elizabeth Blackwell, the first female doctor, and Florence Nightingale, the founder of the Red Cross. So, historically I knew of and admired successful women in science and medicine. But I also admired Louis Pasteur and other great people in science history. For me, it was the subject and not really the race or gender of the person. However, Sister MJ's race and gender did impact me a little. I remember thinking here was this white women encouraging me to achieve and because I respected and liked her I

listened. But I do believe that if she had been black or a man I would have also listened because it was my love of science that really pushed me forward.

Key Collective Science Teaching and Learning Beliefs

This section discusses collective findings and relationships related to individual belief themes emerging from the data. It focuses on the two major collective instructional practice beliefs identified by the participants: the use of inquiry and the use of computer technologies. Table 4.5 provides an overview of inquiry as it was described by each participant including why each participant believed they used inquiry.

Table 4.5

Key Components of Inquiry

Case	Components of Inquiry	Why use inquiry?
Queenlateacher	• questioning to elicit prior knowledge • the use of demonstrations or lectures to provide background knowledge and motivate students • the use of open-ended labs to think and explore ideas • the use of cooperative learning	• Fosters the use of real-world applications of science • Develops student interest in science
Lucy Line	• Characterized by the use of real-world or authentic problems, the use of students' prior knowledge, the use of questions, and giving students opportunities to communicate their findings	• Allows students to make predictions and explore concepts they are interested in.
Zora Walker	• Characterized by the use of open-ended questions to help students solve real-world or "authentic "problems	• Emulates the work of real scientists.

Computer Technologies

This section explores the participants' computer technologies beliefs and experiences. Each participant in this study believed that computer technologies should be used in the classroom. They also believed they were not using the technologies as effectively as they could for reasons that will be explored in this section. From the data five basic beliefs participants had about using computer technologies were identified. Participants believed that using computer technologies:

1. prepared students for future careers,
2. helped students understand science better,
3. increased students understanding of the research process,
4. allowed students to have access to people and information they would otherwise not have contact with, and
5. improved their teaching and productivity.

Table 4.6 provides an overview of the types of computer technologies participants had access to and where it was located.

Table 4.7 provides an overview of each participant's professional development and personal experiences with computer technologies. Queen attended the state-mandated INTECH professional development course when it was offered by the district some years ago. It focused on using instructional technology in the classroom. Since that time she attended some short educational technology professional development sessions offered during her planning time by the system level instructional technology specialists assigned to her school. These sessions focused on using Office in the classroom or accessing certain websites. Nothing specifically addressing science had been offered. Queen was currently enrolled in an online Master's program in Library Science at the time the study took place.

Table 4.6

Technology Access

Case	Computer Technologies (per teacher)	Location
Queenlateacher/ Lucy Line	1 laptop with printer	Classroom and take home; has wireless capability
	5 desktop workstations with networked printer	classroom
	Internet access –Ethernet	classroom
	Microsoft Office Suite – Excel, PowerPoint, Word, Access	Desktops and laptop
	Browser: Explorer	Desktops and laptop
	Gradebook: Class Action (single license) (Queen); Excel spreadsheets (Lucy)	laptop
	Graphing: Kidszone from National Center for Education Statistics, Excel	Classroom and laptop
	1 multimedia projector	classroom
	1 TV with DVD player	classroom
	1 digital camera	classroom
	10 desktops with Internet access	Media center
	Other: 12 non-scientific calculators (Queen); 24 Casio graphing calculators (Lucy); access to United Streaming video and BrainPop	Classroom/laptop

Table 4.6 *(continued)*

Case	Computer Technologies (per teacher)	Location
Zora Walker	1 laptop with printer	Classroom and take home; has wireless capability
	6 desktop workstations with networked printer	classroom
	Internet access –Ethernet/wireless	Classroom/entire school
	Microsoft Office Suite – Excel, PowerPoint, Word, Access	Desktops and laptop
	Microsoft Moviemaker	Desktops and laptop
	Browser: Explorer	Desktops and laptop
	Gradebook: Gradekeeper (single license)	laptop
	Graphing: Kidszone from National Center for Education Statistics, Excel	Classroom and laptop
	1 ceiling mounted multimedia projector	classroom
	1 presentation station with DVD player	classroom
	1 digital camera	classroom
	1 video camera	classroom
	1 webcam	laptop
	30 Gig video IPOD (self purchased); ITUNES	laptop
	12 desktops with Internet access	Media center
	Other: 12 non-scientific calculators; access to United Streaming video and BrainPop; light meter; Scratch animation software (laptop); Skpe software;	Classroom/laptop

Table 4.7

Computer Technologies - Professional Development and Personal Experiences

Participant	Professional Development	Personal
Queenlateacher	• Completion of state required INTECH course • Enrolled in online masters degree program	• Tracks household finances using financial software • Pays bills online and does banking online • Orders prescriptions online • Creates digital photo albums and PowerPoint presentations for family events • Communicates with family in other states by email
Lucy Line	• Completion of state required INTECH course	• Tracks household finances using financial software • Pays bills online and does banking online • Communicates with family in other states by email
Zora Walker	• Completion of state required INTECH course • Completion of One Computer Classroom Workshop back in the 1990s • Completion of NTTI program • Attendance at National Education Computing Conference (NECC) in 1998 and plans to attend in Atlanta in summer 2007	• Tracks household finances using financial software • Pays bills online and does banking online • Communicates with family in other states by email • Communicates with relatives living in another country and in other states using SKYPE • Creates digital photo albums and PowerPoint presentations for family events • Uses video and Window's Moviemaker to create family movies • "Plays round with software and web technologies" for fun and to determine if she will use it in the classroom. Is currently teaching herself to use Scratch, an animation software from MIT

Lucy Line also attended INTECH training some years ago. Since that time she has also attended the short sessions offered by the instructional technology specialist on her planning time. Other than that she has attended no other professional development sessions and considers herself basically self-taught.

Zora Walker considered herself a pioneer in the use of computer technologies. She bought an Apple II in the 1980's and used to produce worksheets and other classroom materials for her students. She attended some One Computer Classroom workshops in the 1990's. Since then she has participated in the INTECH course and sessions offered on her planning time by the instructional technology specialist assigned to her school. Approximately three years ago she completed a National Teacher Training Institute (NTTI) offered by the public television station owned by her school system and a local university. It focused on using instructional video and Internet in the classroom. During the institute she along with other teachers created lessons that are now posted on the NTTI website.

Table 4.8 provides an overview of the types of the successful experiences each participant reports regularly having in with computer technologies. When the researcher asked them to describe unsuccessful experiences each indicated they have had many, particularly when it comes to using web-based technologies. Either websites were inoperable or Internet access was unavailable in the school when they wanted to use it. However, participants indicated these unsuccessful events did not discourage them from using technology in the classroom. "I just had to learn to have back-up just in case" said Lucy.

All participants felt that using computer technologies helped students have the skill sets they needed for future careers. Participants believed use of productivity software (Microsoft Office) was a basic skill students needed to have in order to get any type of job in the future. Students regularly used Office to prepare reports and presentations. Participants taught students how to create Excel spreadsheets and use Excel to create graphs (as evidenced by documents provided to me by participants). Each participant also believed there were many other types of software and web-based technologies they are not using that would better prepare their students for 21st century careers. Zora would like to see emphasis placed on using software scientist use.

Table 4.8

Types of Successful Classroom Experiences with Computer Technologies

Experience	Case		
	Queenlateacher	Lucy Line	Zora Walker
Use the Internet or productivity software to develop lessons and activities	X	X	X
Use Internet websites and Excel to display data	X	X	X
Use the Internet as part of instruction: Webquests and other websites	X	X	X
Use online databases to conduct research and prepare reports	X	X	X
Use computers to present information	X	X	X
Use computers to increase their productivity: grade books, EXCEL and other Office Suite applications	X	X	X
Use of graphing calculators	-	X	-
Use a to collect data	-	-	X

She stated

> We've tried to integrate GIS (Geographic Information System) and other science software into our science programs. When I attended a National Science Teachers Association meeting, I visited a school in Louisiana where students were using GIS in the classroom to conduct environmental impact studies in their biology class. It was very powerful to see young African American males using this sophisticated software to conduct scientific research. We tried to promote this kind of use of technology in the

> district. But there were many problems with getting the technology and making it operational at that time. So, the program was discontinued. Now that we have the technology, we don't have the strong advocacy we need. No Child Left Behind has really put science on the backburner for the last few years. All technology funds are allocated for mathematics and reading. I know that is supposed to change but I've had entire groups of students who did not have the type of science opportunities they could have had as a result.

Queen would like to know more about using web-based simulations. She stated

> We've all done the virtual frog dissection and I've looked at Virtual Bicycle. I'd really like to know how to effectively teach with these simulations and have some time to practice.

Participants believed computer technologies helped students to understand science better particularly because they allowed them access to information and people they could not communicate with in any other way. The students communicated with scientists through email, visited places around the world through virtual field trips and participated in science research projects (The Jason Project and The Globe Project). Lucy believed the Internet has allowed her to bring African Americans in STEM into her classroom thereby making her subject more relevant for her students. She described a research assignment

> I have students complete a research assignment on African American scientists, mathematicians, and engineers. They must conduct the research using the Internet and prepare a PowerPoint presentation and present the information to the class. What makes this assignment different from traditional research assignments is that students can research contemporary African American scientists. We don't have to wait until they die

> and someone writes about them in a book. In many cases the scientists have websites. These scientists are living and relatively young. Some have backgrounds similar to those of my students. Some students contact their scientist by email. Many of them actually respond and that is certainly something we could not have done in the past.

As previously discussed, participants did not allow unsuccessful experiences with computer technologies to deter them from using the technology. However, they expressed some frustration with how they must structure technology use because many of their students do not have home access. Zora comments reflect those of all participants

> My students do not have access to technology in the home. There is no library in this neighborhood. So, the school is the focus for them. Because of this we have to come early and stay late so students can work on projects outside of the regular school day. I have to structure my class differently because of this. I only have six computers in my room so anytime I use computers I have to use a rotational format. It speaks to how intelligent my students really are. They are able to effectively use the technology with very little access.

Science Teacher Roles.

Table 4.9 lists participants' individual perceptions about their roles as science teachers. Participants indicated their role was also to advocate for students or give back to the community. This involved the participants acting as role models for their students, motivating students to be successful in life and nurturing and supporting students. This role was not always connected to classroom instruction. While the researcher's formal observations were limited to the classrooms of each of the participants, some of the mentoring and advocate activities each of the participants discussed was observed. Every interview started later than scheduled because participants were working on extracurricular projects with students including tutoring, preparing students for speeches at various school and system events, working in the school store to raise funds for a school trip and coaching cheerleaders.

Table 4.9

Individual Perceptions about Their Roles as Science Teachers

Participants	The role of a science teacher is:
Queenlateacher	to help students use science to understand the world they live in. to guide students to scientific understandings. to advocate for African American children.
Lucy Line	to help students learn how to think critically. to act as a role model. to advocate for African American students
Zora Walker	to help students know how the world functions scientifically. to help students become critical thinkers and problem solvers. to act as a role model. to give back to the African American community.

In addition to the role themes outlined in Table 4.9, participants mentioned a collective role theme that involved them motivating and preparing students to negotiate through societal barriers in order to be successful citizens. These included race and class barriers. The participants believed that American society generally perceived African American children as non-achievers and trouble makers. They believed the media reinforced this by focusing on negative images rather than positive images of African Americans. Zora's statement summarizes this belief: She stated, "No matter what I do, I remember that my students have to understand what society thinks of them and how they can overcome these negative perceptions." The researcher asked Zora what she meant by negative perceptions. She stated

> Unfortunately, African Americans are being defined as rappers, criminals, strippers and tagged as being learning deficient because they cannot pass some sort of standardized tests. Everything wrong with society is put on our shoulders. The growth in African American society, particularly since the 1960's is overlooked. In reality there are more black professionals than there has ever been but that is not the message our students receive. So, it is my responsibility to teach them otherwise.

As previously described, Lucy indicated how important it was for her to be a role model to show her students how she was able to achieve as an African American in society. She also stated: There is a perception that people should be able to pull themselves up by their bootstraps. That is ridiculous. My students have to know how to pull themselves up when they have no bootstraps and in some cases no boots. Part of my role is to give them strategies to achieve. To teach them to negotiate their way in a world that is not always open to them. To keep their heads up and not let people tell them they are any less because of who they are and where they are from. That is very difficult when they are constantly being given the message that something is wrong with them or the expectation that criminal behavior or unwed pregnancies are what they should look forward too.

Participants also collectively believed the three roles discussed should be the most important for science teachers because they meet the needs of African American students. They also indicated it was imperative that African American students understand there is a bigger world than their neighborhood and what is valued in their neighborhood. They believed science had the potential to help African American students not only know where places are but understands what happens in those places.

Instructional Practice Roles.

The participants instructional practice roles were categorized into three areas. Table 4.10 provides an overview of these areas.

Table 4.10

Instructional Practice Roles

Role	Description
Facilitator	Uses inquiry-based strategies including cooperative learning, questioning, real world examples, and the 5E model; students are given some input into instructional decision making but majority of decisions are made by the teacher including content decisions.
Traditional	Characterized by traditional teaching practices including lecture and use of the scientific method.
Manager	Characterized by establishment of routines and procedures

In their roles as Managers, the participants created structured learning environments through the use of classroom rules and procedures. All participants had classroom rules posted. Table lists each participant's classroom rules. Table lists classroom procedures. Participants believed that rules and procedures were extremely important in science instruction. Zora's statements summarize what all participants indicated

> This is a science class. Safety should be the number one priority for all science teachers. So, students must have structure including rules to follow. I don't know how any teacher, particularly a science teacher, can teach in chaos. Teachers in this building without rules or not enforcing rules have days filled with chaos. Middle school students will take over your classroom if you let them. They need to know what you expect and that if they do not meet your expectations there will be consequences. I tell my students that I am the

> captain of the ship. I am not their friend, I am their teacher and I have been given the job of teaching science.

Lucy and Queen expressed themselves in ways similar to Zora. Queen referred to herself as the CEO of the classroom while Lucy referred to herself as the Commander in Chief. While each participant believed they were the person in charge of the classroom, it did not mean that students were not responsible for their behavior. Queen stated

> I am not a policewoman. The students are old enough to know what school is about and what they can and cannot do. I have rules but they are responsible for following them not me. I get this clearly understood at the beginning of the school year. Setting classroom rules does not take responsibility from students. It gives them responsibility because they have to make sure they follow them.

Participants believed students need to learn how to follow classroom rules and follow procedures as good practice for future employment. They identified skills such as being on time, having the correct materials, and speaking appropriately to class members as being important. Lucy stated: Our students have to understand that the world does not revolve around them. Some of them have no idea what correct societal behavior is or they don't have enough interactions with others outside of their peer groups. It's important that we provide practice in letting them get used to doing what might be expected of them on a job. They have to learn that it cannot be their way all of the time. I think they understand that at some level because I normally do not have any discipline problems. Participants all stated that overall their students are respectful and that management was not an issue in their classrooms. They indicated that students learn what is expected of them after a few weeks and the school year progresses smoothly.

All participants indicated that because many of their students came from homes without any structure, it was necessary for them to provide it in school. Queen stated

> Many of my students do whatever they want to at home when they want to. Some are out at night until the early morning. There is no designated homework time where parents are helping them do their homework. There is no sitting down for dinner. Students might be at some type of practice like football or dance until 9PM or 10PM and everyone is so tired when they get home they just go to bed. Other students have a parent or parents who are working multiple jobs in order to support the family. In many of these situations, the kids spend most of the time at home alone and run the household the best they can. So I think they welcome structure and rules when they get to school. They don't complain about my rules that much.

Lucy's comments provide further insight. She described a conference she had with the parent of a student who frequently slept in class

> I had a student, a boy, who always slept in my class. Every day he'd fall asleep. Of course he was failing. He already failed the fifth grade and was a year behind. He did no class work and no homework was turned in. He was a very polite child and showed me no disrespect. He just could not stay awake. I sent a note home telling his mother to come and see me before school. I come to school early everyday to meet with parents, prepare for the day, and do other things. She actually came the next day. Her son was present. I told her about her son sleeping all day. Her response was, "I try to tell him he shouldn't stay out all night and should come in and do his homework and go to bed." He just won't listen. She went onto tell me that she was a single parent and she worked three jobs to pay the rent and buy food. Her son and his younger sister had to take care of themselves

> much of the time. She was only off on Sundays. She seemed very tired. I talked with him about the need for his mother to have him help her out and take responsibility for himself and his younger sister in the seventh grade. He told me he stayed out all night hanging out with his friends and messing around with girls. Frankly, I was surprised that so many young people were out on the streets so late at night. He said he came to school because he liked and to eat breakfast and lunch. We talked about him eventually getting into trouble if he continued to stay out. I went and got the school counselor who also talked with him and his mother.

The researcher asked what happened after the conference. Lucy stated

> It turned out to be a huge case that was referred to protective service. They did not remove the children but in this case social services actually helped. The mother ended up quitting two jobs, getting food stamps and rental assistance through a special program. This all miraculously happened within a couple of months of my referral. My student turned himself around. I think having his mother at home more often made all the difference. She was a good parent but she had to work so many minimum wage jobs just to get by. That was a few years ago but I hear he is in high school and doing OK.

As previously stated in the Classroom Observations sections for each participant, it appeared that students interacted well with them and with each other. There was definitely order but students were freely allowed to ask questions and participate in activities. The researcher observed raising hand procedures, group interaction procedures, rest room procedures, sharpening pencil procedures and passing out paper procedures.

Each participant characterized their classroom role as facilitator or traditional teacher depending on the lessons they taught. They associated the facilitator role with use of the inquiry-based strategies they listed. They associated the role of traditional teacher with having students follow labs step by step without any deviation, some types of lecture and other traditional teaching methods. They did not believe that it was necessary to use inquiry-based strategies including letting students guide classroom instruction. Participants indicated they used inquiry in some lessons but used traditional methods in others depending on various circumstances. They were not confident that inquiry-based strategies resulted in higher student achievement on standardized tests. They believed the tests focused too much on recalling scientific facts and did not promote the use of problem solving or critical thinking, which they indicated was the goal of inquiry-based instruction. They also indicated the increased importance of standardized tests would lead to less achievement rather than greater achievement by poor African American students.

Summary

This chapter focused on the beliefs and experiences of the African American female middle school science teacher participants. Chapter 5 will look at the overall implications from the findings.

CHAPTER 5

CONCLUSION

The purpose of this study was to examine the science teaching and learning beliefs and experiences of African American female middle school science teachers who utilized computer technologies in science instruction. It sought to identify and describe their beliefs and document their experiences with and in science education, including how they believed students learn with computer technologies. Science education reform served as the context for this study. In order to answer the study's research questions three qualitative descriptive case studies combined with a life history design were conducted. Cross case analysis was also conducted. The participants included Queenlateacher, an eighth grade science teacher with sixteen years of experience, Lucy Line, a sixth grade teacher in her second year of teaching middle level science, and Zora Walker, an eighth grade teacher with twenty six years of experience teaching middle level science. Data was collected in the forms of life history interviews, other interviews, documents (e.g., professional journey maps and field notes), and observations in the participants' classrooms. In order to describe participants' individual and collective or common beliefs and experiences data was simultaneously collected and analyzed using methods described by Merriam (2001) and Miles and Huberman (1994). The data was triangulated and in order to improve the study's trustworthiness, the researcher's experiences, assumptions and biases were stated.

This chapter discusses the research findings and makes recommendations for future research. Two primary questions and three secondary questions guided this study. The discussion is framed around the primary and secondary research questions.

The Primary Research Questions

Question 1: What are the science teaching and learning beliefs of African American female middle school science teachers who utilize computer technologies in instruction?

Interview and observation data was used to identify and describe the participants' beliefs about science teaching and learning. Participants' beliefs about science teaching and learning were closely tied to their beliefs about their roles as science teachers. Role beliefs are discussed later in this chapter. Two common key beliefs about reform-based science teaching and learning emerged: (1) the goal of reformed-based science teaching and learning should be to prepare students to think critically and solve problems in the real world; and (2) The foundation of inquiry should be the use of real-world applications of science. Participants (Queen, Lucy, and Zora) also identified common inquiry-based instructional practice beliefs. These included: using the 5E instructional model to guide instruction, assessing students' prior knowledge to guide instruction and alleviate misconceptions, and using inquiry-based labs to promote critical thinking and idea exploration. The use of computer technologies was not identified as an inquiry-based practice. However, all participants indicated that using computer technologies was necessary to support real-world applications based science instruction.

The participants' major beliefs appeared to be aligned with the National Science Education Standards goals for scientific literacy. According to Yager and Ackay (2007)

> Scientific literacy enables people to not only use scientific principles and processes in making personal decisions but also to participate in discussions of scientific issues that affect society. Scientific literacy increases many skills that people use in everyday life, like being able to solve problems creatively, thinking critically, working cooperatively in teams, and using technology effectively. (p. 13)

Real-world applications. Participants believed their roles as science educators was to prepare students to become contributing members of society who could solve problems and think critically about issues and events they might encounter. They believed inquiry-based teaching and learning could support this role by focusing on real-world applications of science. In order for students to understand how computer technologies related to science and scientific research, participants believed they were an important component in instruction. Participants' role beliefs are discussed later in the chapter. Shiverdecker (2009) defined real world applications or connections as learning opportunities that portray science content and processes in ways that are relevant to students. He also maintains that real-world applications offer teachers opportunities to help students see science in the world around them and puts science into a context that is meaningful to students.

The participant's beliefs about the use of real-world applications in inquiry-based science teaching and learning were positioned in research focusing on the relationships between science, technology and society (STS). According to the National Science Teachers Association (1990), STS places science instruction in the context of human experience and focuses on real-world problems with science and technology components. In STS scientific observations are used to provide explanations about the natural world and technology is focused on the application of the principles of science to enrich and improve lives, both locally and globally (Hammerman, 2006; National Science Teachers' Association, 1990). According to NSTA features of STS include:

1. student identification of problems with local interest and impact,
2. the use of local resources (both human and material) to locate information that can be used in problem resolution,

3. the active involvement of students in seeking information that can be applied to solve real-life problems,
4. the extension of learning beyond the class period, the classroom, and the school,
5. a view that science content is more than concepts that exist for students to master for tests,
6. an emphasis upon process skills that students can use in their own problem resolution,
7. an emphasis upon career awareness—especially careers related to science and technology,
8. identification of ways that science and technology are likely to impact the future, and
9. student autonomy in the learning process as individual issues are identified and approached.

While findings indicated that participants espoused some science teaching and learning beliefs related to STS, allowing students to make instructional decisions related to topics or problems being studied was not readily apparent. Participants made instructional choices including selection of topics and labs to be covered. One exception was the creation of a school recycling program by Queen's students. However, the program was developed and implemented separate from regular classroom instruction. There was some evidence that participants' students were able to creatively complete assignments when using word processing, presentation and spreadsheet programs. But major instructional decisions were made by the participants. This represents a traditional approach to science teaching and learning. Interestingly, standards-based reform might be a contributing factor to the use of this traditional approach. Critics of standards-based reform maintain that implementation has resulted in uniform curricula and assessments that do not allow teachers to meaningfully incorporate student interests into science instruction (Barton, 2001; Seiler, 2001). Tate (2001) maintains that as science becomes part of the high stakes testing accountability movement test-oriented instructional practices will take the place of inquiry-based practices. Studies indicate that when testing serves as the main accountability measure of teaching and learning, instruction that focuses on test-taking skills and test topics becomes the major focus of the instructional program, particularly with low SES minority populations. (Madus, West, Harmon, Lomax, & Viator, 1992; Tate, 2001). It should also be noted that all participants did not object to the utilization of traditional approaches in science teaching and learning, particularly when they believed teachers had inadequate content knowledge to implement inquiry-based instruction. The participants also believed in-depth content knowledge was necessary in order to utilize inquiry-based practices effectively.

Question 2: *What are the science teaching and learning experiences of African American female middle school science teachers who utilize computer technologies in instruction?*

This section focuses on the two types of experiences emphasized in this study: Pre-teaching and professional development. Pre-teaching experiences were defined as education related experiences or people encountered that influenced the participants' choice of science teaching as a career and educational success. Queen and Zora had early role models who exposed them to science and influenced their decision to become science teachers. These role models were teachers at the elementary (Queen), middle (Queen), high school (Queen and Zora) or college (Queen and Zora) levels who encouraged academic achievement in science and in Queen's case extracurricular participation in science. Both Queen and Zora's paths to science education included the selection of science majors in college and experiences with pre-college science teaching and learning while college students. Queen originally intended to enter medical school but decided on science teaching as a career while completing the student teaching requirement for her education minor. She realized her decision to enter medical school was based on the expectations of others, including her family. However, during her student teaching experience she realized she had a talent for working with students. This talent was also recognized by a professor who mentored and encouraged her to go into science teaching. Zora intended on majoring in science and becoming a science teacher prior to entering college. She was influenced by a science teacher she respected. This teacher encouraged her achievement in science. She also encountered a biology professor who supported her career choice and introduced her to others in education. Zora was also able to tutor at a local school. While Lucy did not report having pre-college or college role models, she did encounter a teacher who motivated her to enter teaching through a non-traditional pathway or alternative certification program. This occurred while she participated as a volunteer mathematics tutor in an industry sponsored pre-college outreach program. Lucy’s path to science teaching was also an alternative path. Lucy taught mathematics for most of her career but was asked to teach science when school enrollment decreased. She had enough coursework in college level science to obtain a middle school endorsement in science.

Based on the findings, the researcher was able to make the following observations about the middle school African American female science teachers in this study: (1) Supportive family members who emphasized educational achievement helped lead them to science academic success. It was not necessary for their family members to have experience with science or with college; (2) Pre-college science teachers acting as role models and mentors impacted their post-secondary choices including college major and career choices. (3) College teachers acting as role models and mentors impacted their college and career choices; and (4) Successful pre-college experiences with science promoted their success in science; and (5) They purposefully replicated the role modeling and mentoring characteristics exhibited by teachers they encountered in their educational practice.

Professional development. Each of the participants in this study took part in district sponsored reform-based professional development. This professional development mainly took the form of 30 hour summer academies emphasizing reformed-based science instructional strategies. Science content was also emphasized. Academy content sessions were developed by science and engineering faculty from a local higher education partner institution specializing in science, technology, engineering, and mathematics. Both Queen and Zora participated in district level summer academies for a number of years. Lucy was in her second year of teaching science when this study took place. She attended one academy prior to the study taking place. All participants reported using the strategies learned in their classrooms. According to the participants the instructional strategies they identified as being inquiry- based were emphasized during the academies they attended. These strategies included the use of the 5E instructional model, assessing student prior knowledge, and inquiry-based labs.

While Lucy's building level administration encouraged her to participate in the academy, it was not required by the district. Because the academies were held during the summer break period, participants self selected. Implementation of instructional strategies emphasized during the academies was also not required by the district. Participants were free to implement content and strategies based on their instructional needs. Follow-up support was typically not provided or required. It was difficult to determine whether implementation of an instructional strategy indicated belief in that strategy. The researcher maintains that some type of reflective process, perhaps connected to the professional development that allowed for the examination of beliefs would be necessary. This issue is discussed later in the chapter.

The Secondary Questions

Question 1: How do African American female teachers perceive their roles as science teachers?

Interview data was analyzed to describe the participants' perceptions about the roles of science teachers. After examining the individual and collective findings, it was determined that all three participants shared similar beliefs regarding the roles of science teachers. These beliefs focused on using science to help students understand the world and helping students to become critical thinkers and problem solvers. Queen, Lucy and Zora viewed science teaching as a tool to help students negotiate their way in American society and to empower students to become successful individuals.

Critical pedagogies in science education. The participants' role descriptions are positioned in research related to critical pedagogies in science and science education, including themes of social justice. According to the tenets of critical pedagogy in science and science education, the ultimate goal of science education should be to provide scientific problems and experiences that empower students to transform their lives. King and Ahlquist indicated that critical pedagogy in science education should also provide students with problems and laboratory experiences that connect them to the social world. Students should be encouraged to look more critically at the local, national and global problems and help develop solutions to those problems. King and Ahlquist (1990) also maintain that: "Science teachers should facilitate student voices so that they become conscious of themselves as knower's, conscious of their own history, and able to name their world in order to act on it" (p. 5).

Gutstein (2003), Ladson-Billings (1994) and MacLeod (1991) outlined successful components of social justice pedagogies that align with the roles of science teachers described by participants. These components are: (1) helping students understand, formulate, and address questions and develop analyses of their society; (2) helping young people develop a sense of personal and social agency; (3) helping students develop positive social and cultural identities by validating their language and culture and; (4) helping students uncover and understand their history. These components appear to be in conflict with the goals of science education reform. According to Calebrase-Barton (2001) current science education reform has resulted in science education that has become more about “presenting students the science they need to fit into society rather than about educating students about how they might produce, use, and critique science to work with and transform society” (p. 848). Furthermore, Calebrase-Barton maintains that “science education has not incorporated the needs or concerns of children in poverty and children from ethnic, racial, and linguistic minority backgrounds” (p. 852).

Moore (2007) indicates that social justice in science teaching can also be understood within the context of multicultural education. Multicultural education seeks to “to improve race relations and to help all students acquire the knowledge, attitudes, and skills needed to participate in cross-cultural interactions” which may lead to “personal, social, and civic action that will help make our nation more democratic and just” (Banks, 2004, pp. vii-viii).

“Other mothering”, giving back to the community and beliefs about students. The participants perceptions about the roles of science teachers also relates to research about African American teachers as caring teachers. Research on caring involving African American teachers connects teaching and mothering and is referred to as “other mothering.” According to Irvine (2002) and Hill-Collins (2000), female teachers feel a sense of “kinship and personal

attachment" to the students they teach and "emotionally adopt" their students each school year. Furthermore according to Irvine, "other mothering" is the result of wanting to help a child because the child is of the same race as the teacher. The "other mothering" teacher does not believe that student achievement is measured by standardized test data. Instead achievement is based on resiliency and defined by the experiences of successful African Americans who have achieved in spite of challenging backgrounds (Foster, 1990, 1997; Hill-Collins, 2000; Irvine, 2002). Participants indicated that students could not be successful in life without the positive motivation provided by them and others in the school. They believed this motivation was necessary and without it students would have difficulty becoming successful, even if they were talented academically. According to Toliver (1993), caring by African American teachers takes several forms and includes giving time outside of the classroom, listening to students' problems, and encouraging students to grow academically. Queen, Lucy and Zora expanded the role of teachers beyond that of transmitters of scientific knowledge. By doing so, according to Beauboeuf-Lafontant (2005), the participants "demonstrated a concern for students' well-being that was tied to concrete action and not simply sentiment. In this way, caring was a form of activism that challenged the subordinate social position of their students" (p. 442).

Participants in this study identified their roles as science teachers in ways that included instructional practice roles but were not limited by them. They identified non-classroom roles that are connected to how the participants want their students to exist in the world and what type of people they want their students to become. The participants saw their non-classroom roles as primarily focusing on helping students understand the world, helping students become critical thinkers and problem solvers, and acting as motivators or advocates for students. Participants stay after school, sponsor activities and bring in role models that increase student awareness of science-based careers, help students build character, motivate students to be successful, and nurture and support students.

Question 2: How do African American female middle school teachers use computer technologies to teach science?

Question 3: What experiences have influenced African American female middle school teachers' beliefs about the use of computer technologies in science instruction?

Since these two questions are very closely related this section discusses them simultaneously. Interview and observation data was used to describe Queen, Lucy's and Zora's experiences with computer technologies in science teaching. Participants' uses of computer technologies in science instruction were based on previous experiences with technology in industry (Lucy) and interest in using new technologies (Queen, Lucy and Zora). They had established routines and procedures for use in the classroom. Students worked individually, in pairs or in larger groups depending on the assignment. While they had no evidence that using computers technologies improved achievement, participants promoted their use because they believed computer technologies motivated students, allowed student to express themselves creatively, connected students to the real world, and helped them develop skills that would be valued in the workplace. Several studies support participants' beliefs related to the benefits of integrating computer technologies in instruction (Means & Olson, 1995; Ringstaff & Kelley, 2002; Swain & Pearson, 2003).

High level and low level uses of computer technologies. Participants regularly had students prepare reports and presentations using productivity software. They indicated they believed the use of productivity software allowed students to communicate their ideas about science and promoted student creativity. Participants also had students use the Internet to conduct research and download videos to use in presentations. Participants indicated they understood how to use the computers for personal uses and as productivity tools for instruction (e.g. creating lesson plans, preparing reports, and keeping grades.) The participants' use of computer technologies was aligned with a report released by the National Center for Education Statistics (2000). While the report did not specifically focus on the use of computer technologies by science teachers, it provided data related to usage by teachers in general. The report indicated 44% of teachers used technology for classroom instruction, 42% for computer applications, 12% for practice drills, 41% required students to use the Internet for research, 27% had students conduct research using CD-ROMS, 27% required students to complete multimedia projects, 21% required students to conduct demonstrations, 20% required students to use computers to solve problems and analyze data and 7% required students to communicate with others using the Internet.

According to the United States Department of Education (2003), teachers in low socio-economic schools are more likely to use computers for practice drills or for rewards such as free time. Researchers identify these types of uses as low-level tasks. The use of word processing, Internet research, and using computers for email are also considered low-level tasks. Researchers have identified using spreadsheets, presentation software and digital imaging in teaching and learning as high level computer tasks. Queen's, Lucy's, and Zora's uses of computer technologies were characterized by the application of high-level and low- level tasks for teaching and learning. All participants used computers for word processing, Internet research, email, spreadsheets, and presentation software. Participants did not report using computers for rewards or free time or for drill and practice.

Beyond low level and high level uses of computer technologies. Participants' use of computer technologies extended beyond low level and high level computer tasks identified in much of the research literature. Participants indentified other uses as necessary for science teaching and learning. These uses included the applications of Internet and non-Internet-based scientific games and simulations (Queen, Lucy, and Zora), video-streaming (Queen), scientific Probeware (Queen), and virtual worlds (Lucy). According to Dani and Koenig (2008) technologies such as simulations and Probeware can be used to support the use of "high quality enhanced science lessons" (p. 204). These technologies also support inquiry-based teaching and learning practices advocated by science education reform (International Society for Technology in Education, 2002; National Research Council, 1996a).

Simulations. Queen used a simulation program to help her students understand and experience physical science concepts such as friction. Zora indicated that she used web-based simulations to explore atomic theory and motion and force concepts. According to Queen and Zora, by using simulations, their students were able to solve problems and make decisions by manipulating variables. Simulations are virtual environments that model representations of complex scientific processes, systems or phenomena (Dani & Koenig, 2008; Stratford, 1997). Friedrichsen, Dana, Zembal-Saul, Munford and Tsur (2001) indicated that simulations can be used in science teaching and learning in the following situations: (a) when performing an experiment would be impossible, (b) when an experiment is too dangerous, or (c) when the timeframe to perform an experiment is too low. According to Dani and Koenig simulations have been used to teach how to do something or to help students experience scientific thinking. Some research also indicates the use of simulations increases student achievement in and attitudes about science (Dani & Koenig, 2008; Kinzie, Strauss, & Foss, 1993; Kurz & Holden, 2001).

However, other studies indicate that the use of computer simulations alone does not result in increased student achievement by middle school students. In a study of 71 seventh grade students in Israel; Stern, Barnea and Shauli (2008) used a simulation software, *A Journey of the World of Particles,* to evaluate the effect of a dynamic software simulation on the understanding of the kinetic molecular theory. Based on pre-post tests comparisons, use of the simulation software increased student understanding on kinetic molecular theory concepts. However, because the overall post test scores were low, the authors concluded the use of simulation software alone was not sufficient to support significant learning.

According to Bell & Smetana (2008) research also indicates the use of simulations replicates the scientific habits of mind that scientists use in their daily work. Scientific habits of mind are mental constructs that allow students to think about, describe and explain objects, phenomena and processes in real-life formats. For example, when Akpan and Andre (2000) compared hands-on frog dissections with virtual frog dissections, they determined students were more focused on learning to solve problems and make decisions rather than on right or wrong answers.

Video-streaming. Queen reported using web based video-streams to teach science. According to Bell and Park (2008) very little research has been conducted on using digital video in science teaching and learning. However, an evaluation of a video-streaming library indicated that students who viewed subject-specific video clips scored higher on content knowledge exams than students who were taught without video. The gains across all age groups were not consistent. This may have due to the lack of video content in some areas or the way teachers implemented the videos in instruction (L. Bell & Park, 2008; Boster, Meyer, Roberto, Inge, & Strom, 2006).

Probeware. Queen used a type of scientific Probeware, photometers, to help students understand the relationships between distance, time and velocity. Probeware or probes consists of electronic sensors, interfaces, and software that are used to collect and analyze scientific data. Probeware can be used with computers or graphing calculators. Many types of probes exist. For example, temperature probes can be used to predict the impact of temperature on aquatic life or study how the tilt of the earth influences warming. Many other scientific concepts can be studied using temperature probes. Soil and water quality can be measured using pH probes. Motion detectors can be used to measure velocity, motion, and speed. Light sensors can be used to study the percent reflectivity of various colors. Data collected using a probe is presented in both spreadsheet and graph formats. The use of probes provides students with authentic scientific learning experiences and allows for more time to be dedicated to experimental design and interpretations (Dani & Koenig, 2008; Linn & Hsi, 2000).

Virtual worlds. Although Lucy had not yet utilized virtual worlds in her classroom she indicated that one virtual world, Second Life or SL, could possibly be used in middle level science instruction. Second Life is an example of a 3D virtual world or multi-user virtual environment (MUVE). In a MUVE, students create characters of themselves called avatars. Avatars move through the simulated world and interact with each other and with objects (Baker, Wentz, & Woods, 2009; Johnson, Levine, Smith, & Smyth, 2009). According to Johnson, Levine, Smith & Smythe (2009) SL extends the classroom and erodes geographic and time limitations that can constrain academic interactions.

The educational uses of MUVE’s at all grade levels and in all subjects, including middle level science is still being explored. Neulight, Kafai, Kao, Foley and Galas (2007) used the MUVE, Whyville, to examine sixth grade students’ understandings of infectious diseases.

Students created avatars that experienced an outbreak of an infectious disease called Whypox. Results indicated that students did not understand the process of transmitting an infectious disease as a biological event. Instead students believed the transmission of infectious diseases resulted from touching rather than from the reproduction of germs from the body. The teacher's role in the classroom was to guide instruction. She fostered discussions about Whypox and infectious diseases and allowed students to explore Whyville on their own. The researchers also indicated student may not have understood the concept of infectious disease transmission because the design of the simulation did not replicate the process correctly.

Real-world connections. While the participants regularly used computer technologies in instruction, they indicated that they did not use software or the Internet in ways that scientists and engineers do. They believed scientist and engineers used software programs to collect and analyze data. For example, because of a workshop she attended at the National Science Teachers Association conference, Zora was familiar with a geographic information system (GIS) program, ArcView. According to ESRI (2009), the company that produces Arcview, it is software used by scientists, engineers, and others to collect, manage and analyze spatial data. They believed that while students' knowledge and use of productivity software and Internet research would make them generally better prepared for high school, college and future careers, it would not teach them about what it was like to be engineers or scientists. They believed it was important for students to develop a "real-world" understanding of the uses of computers in order to motivate them to consider careers in science or engineering and better prepare them for life.

Barriers. Much of the research literature focusing on integrating computer technologies into instruction, including science instruction, identifies barriers that prevent computer technologies form being integrated into the classroom (Ertmer, 2006; Keengwe, Onchwari, &

Wachira, 2008). These barriers include teacher beliefs, lack of teacher confidence, and lack of vision to integrate technology into the curriculum. Participants also indicated they had negative experiences using technology including hardware, inability to access the Internet, lack of software and lack of professional development focused on real-world applications of computer technologies. Despite negative experiences, none of the participants had any reservations about using computers in instruction. This may have been because as science teachers they were used to experiments sometimes not working correctly. Therefore, they may not have been as easily frustrated by lack of success with computer technologies.

Participants' uses of computer technologies in science instruction were based on previous experiences with technology in industry (Lucy) and interest in using new technologies (Queen, Lucy and Zora). They established routines and procedures for use in the classroom. Students worked individually, in pairs or in larger groups depending on the assignment. While they had no evidence that using computers technologies improved achievement, participants promoted their use because they believed computer technologies motivated students, allowed student to express themselves creatively, connected students to the real world, and helped them develop skills that would be valued in the workplace. Several studies support participants' beliefs related to the benefits of integrating computer technologies in instruction (Dani & Koenig, 2008; Means & Olson, 1995; Popejoy, 2003).

Recommendations for Future Research

The theoretical and conceptual frameworks utilized for this study emphasized the use of dialogue to reveal and understand the beliefs and experiences of the study's participants. However, due to time and scheduling dialogue became a secondary factor. While there was dialogue between the researcher and the participants, it did not represent the type of "rich thick" dialogue that was expected between participants. Therefore, one recommendation for future research would be to ensure multiple opportunities for dialogue to occur between participants. Conducting a study over a longer period of time might provide opportunities for dialogue to take place. Again, due to time and scheduling constraints, multiple observations could not be conducted. The purpose of this study was to describe the beliefs and experiences of participants and not attempt to understand the connection between beliefs and instructional practice. However, the researcher believes multiple observations would have allowed for some preliminary comparisons between beliefs and instructional practice. With only one or two observations it was difficult to determine if stated instructional practice beliefs resulted in classroom implementation. Therefore, additional research that examines congruency of beliefs and practice is necessary.

Participants indicated they used the instructional strategies promoted during the professional development academies because they believed in using scientific inquiry. It would be interesting to know if the 30 hour summer academy impacted practice and promoted the use of inquiry. Research indicates this type of professional development model would not impact practice because it was too short and did not allow time for teacher reflection. Therefore, a professional development and a research model that allows teachers to critically reflect on their practice, including the examination of their beliefs, would be more appropriate. This professional development model should incorporate real world applications of science and computer technologies in order to provide opportunities for participants to reflect on their beliefs related to the content and strategies being promoted.

Findings suggested a connection between pre-teaching experiences and teacher beliefs about the importance of role modeling and mentoring to actual practice. Findings also implied that African American middle level science teachers who were mentored by their science teachers before and during college might be more inclined to mentor and act as role models for their students. More research is necessary in order to understand the connections between African American middle school science teacher beliefs about acting as mentors and role models for students and how these beliefs transfer into action. Additionally, the impacts of role modeling and mentoring by middle level teachers on student behavior, student achievement, and student career selection can also be studied.

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APPENDIX A

RESEARCH CONSENT FORM

Research Consent Form

I, _______________________________, agree to take part in the research titled, "How Science Teaching and the Use of Computer Technologies has been Experienced and Understood by African American Females Engaged in the Teaching Profession," which is being conducted by Ms. Donna L. Whiting, from the Elementary and Social Studies Education Department at the University of Georgia (706) 542-4244, under the direction of Dr. Denise Muth Glynn. My participation is voluntary. I can refuse to participate or stop taking part at any time without giving any reason, and without penalty. I can request to have the results of the participation, to the extent that it can be identified as mine, removed from the research records or destroyed.

The purpose of the study is to describe how science teaching and the use of computer technologies has been experienced and understood by African American female teachers. The study is guided by the following question: What are the experiences, beliefs, and perceptions of African American female middle school teachers regarding the use of computer technologies in science instruction? The following secondary questions also guide the study: How do African American female teachers perceive their roles and responsibilities as science teachers? How do African American female teachers use computer technologies to teach science? What experiences have influenced African American female teachers' beliefs and perceptions about the use of computer-based technologies in science instruction? What vision do African American female middle school teachers have for the applications of computer technologies in science instruction?

I understand that after completion of this study, I might be more aware of my technology-professional development needs and be able to determine how I might become technologically literate and use technology in the classroom.

I will be asked to partcipate in the following research activities:

Once the interviews are transcribed, no more than 2 weeks after the interviews are completed, interview transcripts will be shared with me. At that time, I will have the opportunity to clarify any portion of the transcript.

There are no discomforts or risks anticipated.

The researchers will keep my identity confidential. No identifying information about me, or provided by me during the research, will be shared with others, unless required by law. Any records relating to my results or participation will be kept in a locked file which only the researchers can access. After the dissertation is written, the researcher will remove any links between my name and results and will destroy audio recordings.

The researcher will answer any further questions about the research, now or during the course of the project, and can be reached by telephone at: 770-603-1263.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Please sign both copies of this form. Keep one and return the other to the investigator.

____________________	_____________________	________________
Name of Researcher	Signature of Researcher	Date
____________________		
Phone Number		
____________________		
E-mail		
____________________	____________________	_________________
Name of Participant	Signature of Participant	Date

Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address IRB@uga.edu

APPENDIX B

PARTICIPANT INFORMATION FORM

Participant Information Form

Name: ____
Last First MI Social Security #

Home Address: ____
Street/P.O. Box City State Zip code

Home Phone: (   ) ____________________ Answering machine? Y or N

E-mail: _____________________________________

School: ___________________

School System: ________________________________

School Mailing Address:

____
Street/P.O. Box City State Zip Code

Principal's Name: ________________________________

School Phone: (   )______________________________

Superintendent's Name: ___________________________

School Fax: (   ) ________________________________

Educational Background:

Degree Major/Minor Subject(s)/Area(s) University/College Date(s)

____

Certificate Type Subject(s)/Area(s) Expiration Date

____

Current Teaching Assignment:

Course Title Grade Level Periods per day

____

Total years teaching : ____ Currently teaching full-time: Yes ___ No ___

APPENDIX C

INTERVIEW PROTOCOLS

Professional Journey Mapping Follow-up Interview Protocol

Purpose: To examine the professional journey map each participant created more closely and to examine their roles and responsibilities as science teachers.

Each participant will be asked to describe the experiences on their map in more detail. Probing questions will be asked based on what the participant is saying.

Other Questions:

Why did you become a science teacher?

Why do you continue to be a science teacher?

What person or event had the greatest influence on your becoming a science teacher and why?

What do you feel your responsibilities are as a science teacher?

How do you describe your approach to teaching?

What responsibilities do you feel you have with your students?

The Use of Computer Technologies Interview Protocol

Tell me about a time when you successfully used computer technology in instruction?

Why was the experience successful?

What influenced you to use the technology the way you chose to?

Tell me about another time when you successfully used computer technology in instruction?

Why was this experience successful?

What influenced you to use the technology the way you chose to?

Tell me about a time when you used computer technology and the experience was not successful?

Why was this experience not successful?

What influenced you to use the technology the way you chose to?

Why are you using computer technologies in instruction?

APPENDIX D

PROFESSIONAL JOURNAL MAPPING ACTIVITY

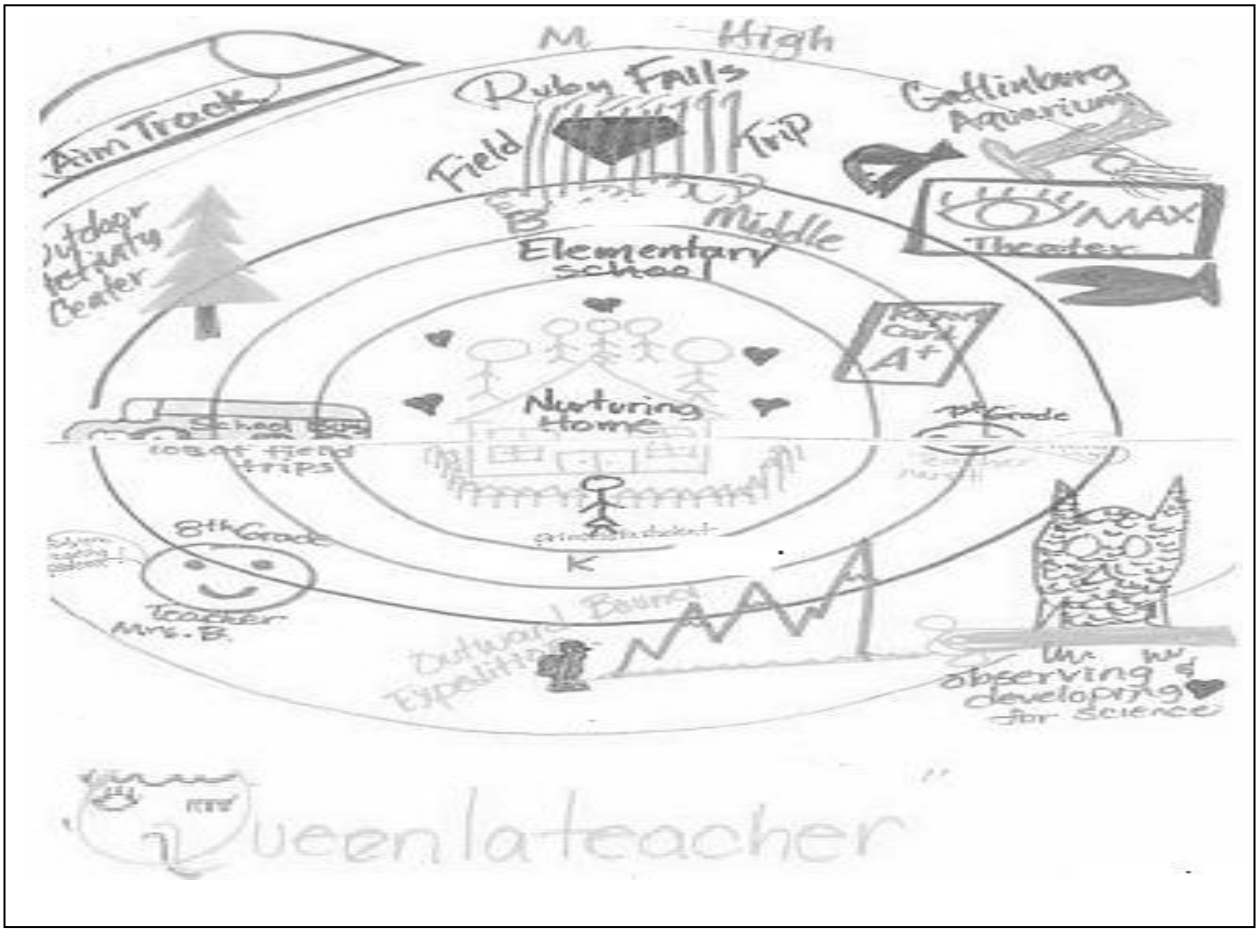
Professional Journey Mapping Activity

On the sheet of paper provided, briefly list the people and those experiences that influenced your choice of a science teaching career. Review your list and circle the experiences and people that had the greatest impact. Looking at the experiences you have circled, draw a pictorial map that charts the course from the first experience you selected to the final experience you selected. Include any other experiences you think were significant to your journey.

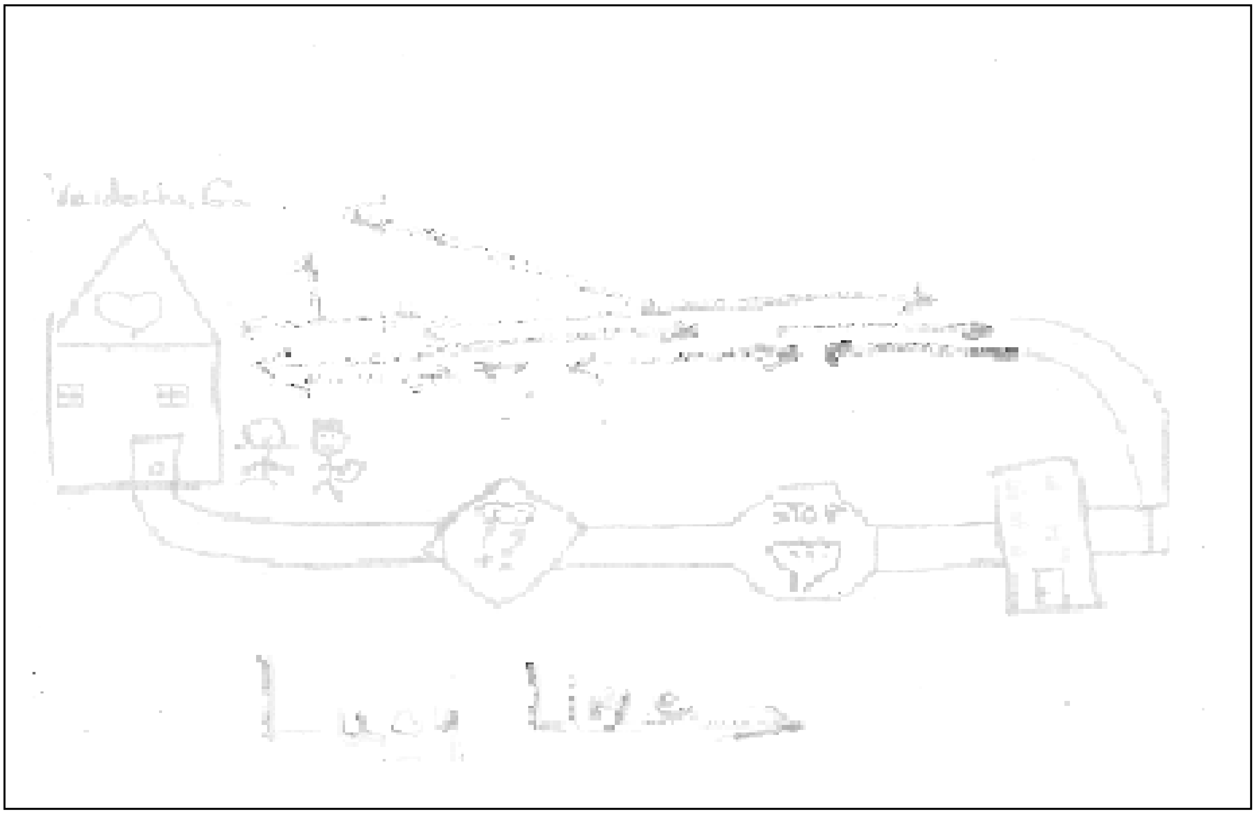
APPENDIX E

PJM SKETCHES

Case 1: Queenlateacher



Case 2: Lucy Line



Case 3: Zora Walker

APPENDIX F

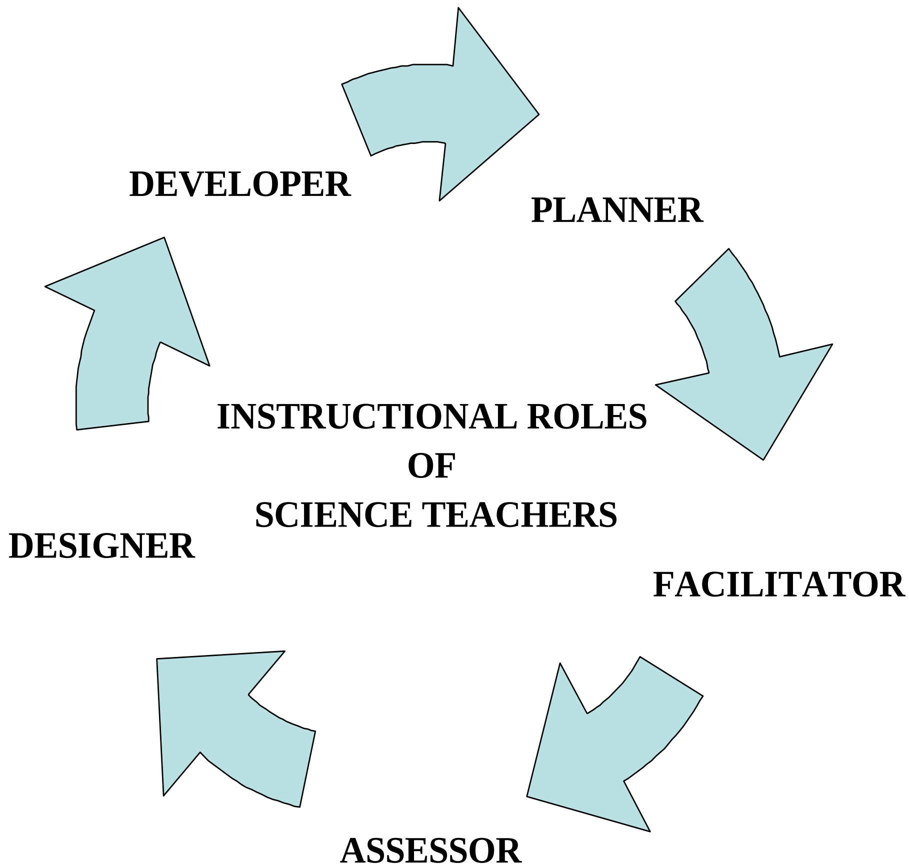
SUMMARY OF THE BSCS 5E INSTRUCTIONAL MODEL

Summary of the BSCS 5E Instructional Model
(R. W. Bybee et al., 2006)

Phase	Summary
Engagement	The teacher or a curriculum task accesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

APPENDIX G

THE ROLES OF THE SCIENCE TEACHER IN THE STANDARDS-BASED CLASSROOM



(National Research Council, 1996a)

The Roles of the Science Teacher in the Standards-based Classroom	
Role 1: The Planner A. Plans an inquiry-based science program. B. Plans and develops the school science program.	• Develop a framework of yearlong and short-term goals for students. • **Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.** • Select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners. • Work together as colleagues within and across disciplines and grade levels.
Role 2: The Facilitator Guides and facilitates learning.	• Focus and support inquiries while interacting with students. • **Orchestrate discourse among students about scientific ideas.** • Challenge students to accept and share responsibility for their own learning. • Recognize and respond to student diversity and encourage all students to participate fully in science learning. • Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.
Role 3: The Assessor Engages in ongoing assessment of their teaching and of student learning.	• Use multiple methods and systematically gather data about student understanding and ability. • **Analyze assessment data to guide teaching.** • **Guide students in self-assessment.** • **Use student data, observations of teaching, and interactions with colleagues to reflect on and improve teaching practice.** • Use student data, observations of teaching, and interactions with colleagues to report student achievement and opportunities to learn to students, teachers, parents, policy makers, and the general public.

The Roles of the Science Teacher in the Standards-based Classroom	
Role 4: The Designer Designs and manages learning environments that provide students with the time, space, and resources needed for learning science.	• Structure the time available so that students are able to engage in extended investigations. • Create a setting for student work that is flexible and supportive of science inquiry. • **Ensure a safe working environment.** • Make the available science tools, materials, media, and technological resources accessible to students. • Identify and use resources outside the school. • Engage students in designing the learning environment.
Role 5: The Developer Develops communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.	• **Display and demand respect for the diverse ideas, skills, and experiences of all students.** • **Enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community.** • **Nurture collaboration among students.** • Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse. • Model and emphasize the skills, attitudes, and values of scientific inquiry.