

To the Graduate Council:

I am submitting herewith a dissertation written by Yolanda F. Kirkpatrick entitled “Teacher Perceptions of Their Science Teaching and Student Learning for Diverse Learners.” I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy with a major in Education.

Major Professor

We have read this dissertation
and recommend its acceptance:

Committee Member

Committee Member

Committee Member

Accepted for the Council:

Vice Provost and Dean of the Graduate School

Teacher Perceptions of Their Science Teaching and Student Learning for Diverse Learners

A Dissertation Presented for

the Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Yolanda F. Kirkpatrick

August 2012

Abstract

Within the United States, teacher preparation programs are challenged by the complexities of race, ethnicity, socioeconomic status, language, and other forms of differences teachers must consider for effective instruction and learning for diverse learners. Although increasing attention has been given to issues linked to diversity and multicultural education, there is a paucity of literature available to prepare and support science teachers for a changing context of diversity and greater demand for effective science instruction (Darling-Hammond & Bransford, 2005; Lee & Buxton, 2010).

The current qualitative study was informed by contributions from a social constructivism framework and Bronfenbrenner's ecological model. These conceptual frameworks support the notion that individuals interact and function within multiple contexts (i.e., family, community, cultural, institutional) that have important implications for how they construct meanings from interactions and experiences that shape their worldview and learning (Bronfenbrenner, 2005; Lewthwaite, 2011; Southerland & Gess-Newsome, 1999). The study was designed to capture and examine conceptions six science teachers shared about diversity and their experiences as learners and teachers of science for diverse learners. The goal of the study was to raise awareness about teacher perceptions of their preparation and support for teaching science in a context of growing diversity.

One-on-one in-depth interviews, using open-ended questions, were audio taped and transcribed to identify and examine themes and patterns of the participants' perspectives. In summary, findings revealed the 1) teacher conceptions of diversity and the meanings they attach to them, 2) preparation and support for teaching science to diverse learners, 3) teaching philosophy and role of science education, and 4) disconnect between theory and practice.

Table of Contents

Chapter 1: Introduction	1
Background	1
Statement of Problem	3
Purpose of Study	3
Significance of Study	4
Research Questions	6
Definitions	Error! Bookmark not defined.
Organization of Study	9
Chapter 2: Literature	10
Introduction	10
Traditions of Teacher Preparation	10
Nature of Science	13
Culturally Responsive Pedagogy	16
Urban Contexts	24
Theoretical Frameworks	26
Conclusions	28
Chapter 3: Methods	30
Introduction	30
Research Design and Theoretical Frameworks	30
Interview	35
Participants	35
Data Sources	36
Data Analysis	38
Establishing Trustworthiness	40
Chapter 4: Research Findings	41
Introduction	41
Teacher Participants	42
Research Question 1: What are science teachers' conceptions of diversity?	45
Defining Diversity	46
Teaching Philosophy	49
Multicultural Discourse	53
Research Question 2: How do science teachers describe their knowledge of teaching diverse learners and sources that guide their understanding?	58
Inservice and Professional Development	58
Classroom Experiences	63
Science Education Literature and Strategies	66
Research Question 3: What types of teaching strategies relevant to diversity do science teachers use?	70
Teacher-student Interactions	70
Curriculum and Instruction Considerations	74
Chapter 5: Conclusions, Discussion, and Suggestions for Future Research	83
Introduction	83
Addressing the Research Questions	84

Study Limitations	93
Study Implications	94
Future Research	95
References	96
Appendix	113
Vita	120

Chapter 1: Introduction

Background

Gaps in science achievement are visible as early as kindergarten and often persist and widen across grades K-12 (National Science Foundation, 2010). Unfortunately, as a result critical masses of K-12 students, who are poor and racially diverse, remain at a disadvantage in most academic areas especially in the areas of science and math (Sirin, 2005; The President's Council of Advisors on Science and Technology, 2010). Findings published by the National Center for Education Statistics (2011) suggest that on average, White students score higher on science assessments than African American, Hispanic, Asian/Pacific Islander, and American Indian at 8th grade. Likewise, at grade 12, White and Asian/Pacific Islander students scored higher on science assessments than other racial/ethnic groups. In view of negative science patterns and outcomes in our society and world, rethinking teacher preparation for meeting the needs of all students should be an educational priority. With attention given to the current challenges of teaching a diverse student population, it is apparent teachers must be prepared with the knowledge, skills, and dispositions for addressing the needs of students of all races and cultures.

Sleeter (2001a) identified several issues linked to science education and teacher preparation to consider: 1) mismatch between teacher preparation and the background, experiences, and cultural practices of many of their students; 2) paucity of studies addressing effective teacher preparation for diverse learners; and 3) general similarities in attitudes and experiences between teacher educators and pre-service teachers about working with diverse student populations and the understanding needed to inform and

guide border crossing. National policies and practices shaping science education reform efforts, including *Benchmarks for*

Science Literacy, *National Science Education Standards*, No Child Left Behind Act, and *Blueprints for Reform*, have not provided sufficient guidance and direction to support teachers to teach diverse learners. Within the United States, successful teacher preparation is further challenged by the complexities and interactions of race, ethnicity, socioeconomic status, language, and other forms of differences. For example, findings from nationally representative survey data (U.S. Department of Education, 2001) revealed that only twenty-seven percent of teachers felt very well prepared to teach limited English proficient and thirty-two percent felt very well prepared to address the needs of culturally diverse students.

Conclusions from a survey study suggest that formal professional development generally centered on teacher knowledge in two areas: 1) methods of teaching, and 2) content guided by performance standards and student assessment (U.S. Department of Education, 2001). Given the current emphasis on science content and student performance based on high stakes testing, teachers appear less likely to participate in professional development centered on culturally responsive pedagogy (U.S. Department of Education, 2001; Sobel, Gutierrez, Zion & Blanchett, 2011; Young, 2010). Exploring these findings in the context of pre-service teacher preparation and in-service professional development as well as the meaning they have for teachers who work with diverse learners is important for closing the gap in student achievement. Included in Chapter One is the statement of the problem, purpose of study, significance of study,

research questions, definition of terms associated with the research, and the organization of the dissertation.

Statement of Problem

Concern about student engagement based on classroom observations during science instruction and activities led to a focus on three issues related to science teacher preparation for diverse learners: 1) lack of knowledge and skills to implement science curriculum and instruction effectively to teach diverse learners best; 2) inadequate models and examples of best practices for preparing teachers to teach diverse learners despite newly evolving efforts to address some of the challenges and available opportunities; and 3) situations where teachers teach science as they were taught or with minimal, if any, pre-service or in-service training for understanding or addressing the changing student demographics. The expectation is this study on teacher perceptions will contribute to the insight needed for deepening understanding of diversity; theories, knowledge, and ideas that informed teaching practices for diverse learners; and strategies and methods they used to engage and teach their students.

Purpose of Study

The purpose of the current study is to explore and share findings based on in-depth interviews with six study participants and to use their insights to contribute to the emerging body of literature on teaching science to diverse learners. The expectation is this study of teacher perceptions will contribute additional insights for preparing teachers to engage diverse learners in a manner that connects science learning to their daily life

experiences and support teachers' efforts to reach, teach, and mentor all students in their classrooms.

Significance of Study

Between 2000-01 and 2007-08, the public school enrollment of White students decreased from sixty-one percent to fifty-six percent (Aud, Fox, KewalRamani, 2010). During this same time period, the public school enrollment of Hispanic students increased from seventeen to twenty-one percent and Asian/Pacific Islander students increased from four to five percent (Aud, Fox, KewalRamani, 2010). The public school enrollment of Black (seventeen percent) and American Indian/Alaska Native (one percent) students remained unchanged (Aud, Fox, KewalRamani, 2010). Approximately, 11.2 million children speak a language other than English at home (Aud, Hussar, Kena, Bianco, Frohlich, Kemp, & Tahan, 2011). Most teachers are members of European cultural groups whose first language is English.

Critics of longstanding research and practices in teacher education contend that *science for all* will not be achieved until reform efforts address teacher quality and teacher effectiveness to teach diverse students (Bryan & Atwater, 2002; Fraser-Abder, Atwater, & Lee, 2006; Seiler 2001; Talbert-Johnson, 2006). How teachers' perceive and respond to the cultural diversity of student populations is a critical aspect of this study. The study is designed to engage teachers in conversation by asking open-ended questions instructive for improving science teaching and broadening the knowledge and skills supportive of the participation and achievement of diverse learners (Aschbacher, Li, &

Roth, 2010; Boutte, Kelly-Jackson, & Johnson, 2010; Bryan & Atwater, 2002; Lee & Luykx, 2006; Settlage & Southerland, 2007; Sleeter & Owuor, 2011).

The dramatic shift in student demographics is potentially challenging for teachers to make sense of their intentions and practices (Elmesky & Tobin, 2005; Kelly-Jackson & Jackson, 2011). Science education seems to focus more on seeking universals by constructing general models and theories of science learning and teaching (Rodriguez & Kitchen, 2005). Zuniga, Olson and Winter (2005) refer to the phenomena of the marginalization and disengagement of students in science classes as ethnic segregation. They contend that this form of segregation results in the separation or isolation of students from mainstream science or core courses. Yet, today's teachers will most likely teach a diverse set of students who are culturally and linguistically diverse and learning should be tailored to meet these students learning and life needs. Teacher educators and administrators must develop effective and creative programs to prepare teachers with the attitudes, knowledge, and skills to teach science to culturally diverse students and ensure excellence and equity in science education for all students.

The current study is significant because it gives attention to science teachers, perceptions they have of their learning experiences, and the ways they try to make sense of engaging students and teaching in a context of growing diversity. This work addresses the gap in the current literature by placing a stronger emphasis on understanding the character of knowledge that enables teachers to effectively teach diverse learners, how the ways teachers teach is influenced by personal preparation and professional development, and how teachers perceive these practices to facilitate student learning. The

disproportionately low participation and achievement of diverse learners in science has serious implications and consequences related to future educational opportunities, employment opportunities, and the ability to make thoughtful decisions about science-related issues (National Science Board, 2010; Webber, 2004). In the sections that follow, research questions are presented and definitions of terms related to the research are presented.

Research Questions

The follow questions will be addressed in the current research:

1. What are science teachers' conceptions of diversity?
2. How do science teachers describe their knowledge of teaching diverse learners and the resources they use to guide their understanding?
3. What types of teaching strategies do science teachers use to reach and engage a diverse population?

Definitions

The following is a list of terms, with their definitions included to assist in clarifying specific vocabulary, used in this dissertation.

Culturally Responsive Teaching – instruction that integrates cultural referents in the curriculum to facilitate students' intellectual, social, emotional, and political development (Ladson-Billings, 1999).

Emancipatory knowledge – self-awareness or critical reflection and self-reflection (Cranton, 2002).

Marginalized students – students that have not acquired the standard language and do not share the cultural values and practices of the dominant American culture (Lee & Lukyx, 2006).

Multicultural competence – is “a field of inquiry with constructs, methodologies, and processes aimed at providing equitable opportunities for all students to learn quality science” (Atwater, 1998, p. 821).

Multicultural education – education with the goal of providing equal educational opportunities for all students, regardless of their racial, ethnic, social-class, and cultural background (Banks & Banks, 2004). Another major aim of multicultural education is to ensure that all students acquire the knowledge, attitudes, and skills needed to function effectively in society.

Multicultural efficacy – construct about personal teaching efficacy, intercultural experiences, minority group knowledge, attitudes about diversity, and knowledge of teaching skills in multicultural settings (Guyton & Wesche, 2005).

Multicultural science education – as described by the National Science Teachers Association (2000) adheres to the following tenets: 1) nurtures all children academically, physically, and in development of a positive self-concept; 2) provides access to quality science education experiences that enhance success and provide the knowledge and opportunities required to become successful participants in society; 3) incorporates the contributions of many cultures to our knowledge of science; 4) integrates culturally-related ways of learning in instructional practices; and 5) recognizes and respects differences students bring based on their cultures.

Nonmainstream students – particular categories of students marginalized from mainstream cultural and linguistic norms; most “are characterized as non-White, and a disproportionate number come from low-income families” (Lee & Lukyx, 2006, p. 10).

Pedagogy – “the art, profession, or study of teaching” (National Center for Education Statistics, 2012, Retrieved from <http://nces.ed.gov/pubs/eiip/eiipgls.asp>).

Preservice Teacher – “a student within a teacher preparation program” (Suters, 2004, p. 16).

Science education program – includes the graduate coursework, field experiences, and teaching internship for science certification.

Student diversity – student differences described in terms of students’ race/ethnicity, culture, home language, and socioeconomic status (Lee & Luykx, 2006).

Social constructivism – is a theory that states that learning is social in origin and embedded in sociocultural contexts. This theory emphasizes the role of the community of significant others in one’s learning. Also, social constructivism focuses on the role of language in students’ meaning-making processes (Vygotsky, 1978).

Teacher – “a practicing teacher” (Suters, 2004, p. 16), education instructor, general education instructor, K-12 teacher/principal/counselor, or other staff in education.

Teaching philosophy - “assumptions, attitudes, beliefs, and practices” (Cochran-Smith, 2004, p. 83) and how they enact these qualities to teach.

Urban schools – qualitatively defined as schools located in a city school district rather than a rural, small town, or suburban area.

Organization of Study

This dissertation is presented in five chapters. As stated earlier, Chapter One provides the introduction to the dissertation. Chapter Two offers an overview of relevant literature used to inform and guide the current study. Chapter Three outlines the methods, data collection and data analysis process, and articulates the theoretical frameworks that guide and provide important insights for this study. In Chapter Four, the findings are presented and emerging themes captured. The final chapter presents the discussion of findings, limitations of the current study, and implications for future research.

Chapter 2: Literature

Introduction

The attention to the preparation of science education teachers is important to facilitate equitable learning opportunities and participation in science experiences (American Association for the Advancement of Science, 1990; Lee & Buxton, 2010; Sirin, 2005). Disproportionate numbers of teachers are inadequately prepared to teach diverse learners (Darling-Hammond & Bransford, 2005; Irvine, 2003; Murnane & Phillips, 1981; Oakes, 1990; Zeichner, 1992). Wise (2001) describes teacher preparation in this country as the “dirty little secret in education” (Chicago Sun-Times, September 7, 2001 Online). By this, Wise was referring to the inadequate education and training of teachers that remained a silent part of the discourse on teacher preparation. The purpose of this section is to present literature related to teacher preparation and instruction for diverse learners. This literature review explores traditions of teacher preparation, the discourse surrounding the nature of science, emerging discourse related to culturally responsive pedagogy for diverse learners, and consideration to the role and influence of contexts (i.e. urban, rural, economics, historical). First, the literature review considers research traditions of work on teacher preparation.

Traditions of Teacher Preparation

Zeichner (1993) identified four traditions (academic, social efficiency, developmentalist, and social reconstructionist) observed in colleges of education and elaborates on the influences of each tradition on teaching practices. These traditions provide insights related to teacher preparation and potential influences on teaching and

learning. Teachers prepared in the academic tradition may favor pedagogy that primarily focuses on the academic content. Proponents of the academic tradition argue that mastery of subject matter knowledge is the foundation of effective professional education. That is, effective teachers are grounded in the content knowledge of their discipline. However, supporters for teachers trained in the social efficiency tradition tend to focus on techniques and skills of teaching and less on discipline-based competencies. Teacher preparation from a social efficiency tradition is competency-based and subdivided into practices and skills based on perceived ideas of the work performed by teachers. Child development theories are the critical elements guiding teacher preparation in the developmentalist tradition. Advocates of the developmentalist tradition argue that teachers with knowledge of child growth and development are more student-centered in curriculum and instruction. Finally, proponents of a more social reconstructionist tradition, give attention to the role culture provides as a basis of reflective inquiry or the partnership of education and social justice, and the role of teachers in social reconstruction.

The four traditions allow one to reflect upon teaching and learning from different perspectives with consideration for which perspectives may be most effective for optimizing the learning of diverse learners. It is the social reconstructionist tradition, however, that explicitly addresses culturally responsive pedagogy in teacher preparation. The next section offers an examination of literature selected because of the emphasis placed on teacher preparation for diverse learners.

Cochran-Smith (2004) argues that it is essential in teacher preparation to guide teachers explicitly if they are to develop an appropriate understanding of preparation for diverse learners. The author believes if teachers are to teach effectively across student diversity, then they must explore issues of culture and history in their classes. Cochran-Smith (2004) maintains that teacher preparation is “embedded in culture and history” and requires a historical framework for understanding current issues and challenges linked to teacher education. Therefore, it is important to review and examine traditional teacher training and understand the tightly entwined pedagogical practices for teaching diverse student populations and the dominant beliefs and practices of teacher preparation. Such a review is necessary for understanding the hidden impact of the established social structures on teacher training in the context of social justice and the meanings they suggest for teacher practices and student outcomes. Over recent years, teacher education programs have been exploring the strategy of field experiences to combat the [perceived] shortcomings of teacher preparation programs (Cochran-Smith, 2004; Gay, 2002; Villegas & Lucas, 2002).

One of the often-cited shortcomings is the overwhelming majority of pre-service candidates are White and middle-class. In general, the pre-service internship for teachers is confined primarily to learning experiences centered on pedagogy in relation to a single classroom and the students they interact with as their frame of reference. For this reason, Allen and Hermann-Wilmarth (2004) chose field experience settings and conditions in which the diversity in the student population is obvious. Consequently, pre-service teachers were forced to see their own culture and that of their students. Gallego (2001)

added that community-based field experiences provide an opportunity for preservice teachers to learn in cultural context.

Despite the potential contributions of field experiences as an important context for deepening pre-service teacher understanding of culture and some of the daily encounters of the student, families, communities, the literature on science teacher preparation highlights and suggests some of the limitations of field experiences for preparing science teachers to teach diverse learners. For example, in meta-analysis research conducted by Hollins and Guzman (2005) the authors noted few generalizations could be made about the impact of field experiences on teacher preparation for diverse learners. They found that the studies they reviewed were conducted in a range of settings and under a variety of conditions. Results from the studies did not clearly demonstrate applications for more effectively teaching science to diverse populations. Regarding findings from an induction program investigated by Bianchini and Brenner (2010), teachers reported that they perceived little contribution to their knowledge about effectively teaching science. However, participants did report their teaching internship had a more powerful and lasting influence in shaping how they taught science.

Nature of Science

One of the contemporary debates, related to the nature of science, centers on what is a valid view of science. Two main factions in the debate are proponents of the traditional pro-Western science view and contrastingly those who maintain that pro-Western science is just one of a number of valid scientific views. This debate is significant and relevant to teacher preparation. Teachers' scientific epistemological views

reflect their core values and worldview; they are essential components for guiding instructional practices (Tsai, 2006). For example, teachers with positivist-aligned epistemologies tend to focus on students' science scores on tests. Instructional time is often devoted to teacher-directed lectures and tutorial or practice sessions (Tsai, 2006). In comparison, teachers with more constructivist-oriented scientific epistemologies tend to give greater priority to student understanding and application of the scientific concepts. Instructional time often includes student inquiry activities and interactive discussions (Tsai, 2006).

The discourse on the nature of science gives rise to discussions about what should be acknowledged as the epistemology of teacher preparation. In the tradition of Western science and the tradition of school science, teacher preparation for diverse learners is defined from a Western modern perspective (Sleeter, 2001). One resolution is that preservice teachers should be encouraged to question and investigate all appropriate ontological and epistemological views that arise in teaching science (Matthews, 1998; Stanley & Brickhouse, 1994). For scientists and science educators, there is an uncomfortable truce to address multiple epistemologies or to teach a sort of epistemological pluralism (Bianchini & Solomon, 2003; Cobern & Loving, 2001).

Ogawa (1995) proposes an epistemology of multiscience, a perspective that extends scientific literacy into the traditional knowledge and wisdom of the ethno-science of indigenous peoples. The multiscience perspective recognizes different types of science knowledge, including personal science, indigenous science, and Western modern science. Proponents of a multiscience education perspective posit that multicultural science

education is a powerful and significant tool for including diverse epistemologies and improving instructional practices (Stanley & Brickhouse, 2001; Ogawa, 1995; Hodson 1993). The movement of a multicultural focus in science education has given rise to much discussion about equity and the culture of power in science education (Banks & Banks, 1995). The societal imbalances of power based on race/ethnicity culture, language, social class, and gender have been replicated in schools and serve to reinforce and maintain traditional structures and systems reflected in the larger society and the roles and functions of various social groups and individuals. The outcome is often a marginalization of specific groups of students and conditions unfavorable to maximum student participation (Darling-Hammond, French, & Garcia-Lopez, 2002; Freire, 2005; Giroux, 2001; Lee, 1999).

Davis and Martin (2008) contend that teaching science from a Western perspective may result in scientific racism. These authors defined scientific racism as science curriculum and instruction supporting and validating racist beliefs or political and ideological positions of Eurocentric cultures (Davis & Martin, 2008). Marzano (2010) offers yet a different approach with a focus on inclusivity with diverse learners. The author had students to create nonlinguistic representations such as graphic organizers, sketches, and pictographs to construct images of science concepts. The study suggested the use of nonlinguistic strategies contributed to student engagement and improved science learning (Haystead & Marzano, 2010).

Gay (1997) argued that teachers will be challenged to teach diverse learners effectively if their preparation does not emphasize the importance of integrating the

academic knowledge and daily life experiences of their students. As Murrell (2000) has shown, a contextualized knowledge of the culture, community, and identity of students and their families provides the core of multicultural teaching practices. Rodriguez (1998) described multicultural praxis as a model encompassing pedagogical strategies reflective of understanding that power and privilege, ethnicity, gender, and voice influence the when, why, and how of what is to be learned. An understanding of multicultural education is related to a grasp of culturally responsive pedagogy and allows one to compare frameworks for teacher preparation and to understand how and why multicultural education is different from traditional patterns of teacher preparation (Atwater, 1998).

Culturally Responsive Pedagogy

Boutte, Kelly-Jackson, and Johnson (2010) found developing culturally responsive praxis requires teachers to reposition themselves as learners, and engage and collaborate with their students, community members and other teachers of diverse learners to expand their knowledge of the cultural resources of their students. Parsons (2000) and Parsons, Foster, Gomillion, and Simpson (2007) illustrated that Black cultural ethos fosters cultural congruence between diverse learners and school science. Parsons (2008) offered Black cultural ethos, a set of West African cultural practices including oral tradition and role playing, as an example of culturally responsive pedagogy.

Despite the promise that the concept of culturally responsive pedagogy seems to hold for supporting multicultural science education for teacher preparation, culturally responsive pedagogy is a concept that is often used “synonymous with ‘minority’

education” (Ladson-Billings, 1999). Over the years, the focus has shifted from a concentration on minority education, to emerging and robust body of literature on culturally responsive pedagogy. Developing an understanding of culturally responsive pedagogy and its application to teacher preparation is fundamental to multicultural education and praxis. Strategies to implement culturally responsive teaching into educator preparation have been documented and include cultural synchronization, critical examination and reflection, community ethnography, and the use of learning communities (McAllister & Irvine, 2002; King, 1997; Cochran-Smith, 1995; Haberman, 1995; Irvine, 1990).

Murrell (2000) and Rodriguez (1997) wrote of multicultural praxis or the knowledge, skills, and abilities to provide exemplary and equitable teaching of diverse student populations. Culturally responsive pedagogy is a function of multicultural praxis with an effort to integrate cultural referents into the curriculum (Ladson-Billings, 1999). Certain methods and instructional strategies enable teachers to engage in culturally responsive teaching and learning interactions with their students. Examples of methods and instructional strategies for learning to teach science to diverse learners are discussed in the next section.

Irvine (1990) introduces the concept of “cultural synchronization”. She found that teachers must develop a connection with their students that starts with valuing and being sensitive to student culture. Irvine (1990) reported that cultural synchronization between the teacher and her students contributes to an effective style of teaching and increases the likelihood of students’ academic success. Cochran-Smith (1995) emphasizes that teachers

need opportunities in their university courses to reflect critically upon their beliefs and values. Cochran-Smith (1995) supports the idea that teachers have opportunities to confront and evaluate their personal assumptions about their students and to experience the culture and community of their students.

Joyce King (1997) sought to have her students develop a relationship with community members. She observed that the student teaching experience often occurs without emphasis on the development of relationships between pre-service teachers and the school, community, and homes of their students. Additionally, King (1997) was concerned that teachers may see teaching diverse student populations as opportunities for integrating the teacher's cultural beliefs and values and consequently may struggle with an understanding of and respect for diversity. Haberman (1995) posits that teacher education programs establish communities of teachers who are committed to teaching all students and to setting high expectations for their learning. Additionally, Haberman (1995) wrote that the demonstration of a commitment to teaching and learning must be criteria for the admission of candidates to teacher education programs.

Although the ideas of Irvine, Cochran-Smith, King, and Haberman demonstrate unique and somewhat divergent views, collectively they provide a range of perspectives for fostering culturally responsive pedagogy. Their collective wisdom suggests teacher preparation curriculum must include the following experiences: 1) sound theoretical understanding of teaching; 2) introduction to the best practices of teaching via one or more models; 3) initial practice under the tutelage of a community expert; 4) ongoing practice with reflection on their own teaching; 5) continued professional development,

support, and mentoring; 6) instruction on how to integrate students' culture and community in school life; and 7) preparation for engaging students in the process of learning.

Buxton (2010) builds upon past traditions and incorporates the evolving paradigm of culturally responsive pedagogy. In this model, the emphasis is placed on engaging learners in social problem solving of their local community environmental issues. Results suggested that students' science content knowledge increased during their participation in this two-week nature summer camp. Researchers (Silva, Sabino, Adina, Lanuza, & Baluyot, 2011) explored the 4MAT Teaching Cycle to teach diverse learners. The focus of the researchers' work was student engagement, inquiry, and collaboration. Concluding insights revealed that individual students receive and process their learning experiences in different ways, and students build knowledge through experiential learning. This is yet another method of addressing issues of student differences.

Similarly, Villegas and Lucas (2002) reported that content of the established preservice curriculum needs to be reconsidered. Villegas and Lucas (2002) suggest six interconnected and intertwining strands or constructs for organizing the curriculum for pre-service teachers: 1) gaining sociocultural consciousness, 2) developing an affirming attitude toward students from culturally diverse backgrounds, 3) developing the commitment and skills to act as agents of change, 4) understanding the constructivist foundations of culturally responsive teaching, 5) learning about students and their communities, and 6) cultivating culturally responsive teaching practices (Villegas & Lucas, 2002, p. 26). Ferguson (2008) developed multicultural teaching standards for a

science education methods course to facilitate the communication in science education between multicultural education and science education. The preservice science teachers were required to have dialogic conversations, participate in and interact with cultures different from their own authentically, focus on professional development and improvement in teaching practices, reflect on the ecological factors influencing their practices, and engage in opportunities for critical reflection and thought (of their practices, students, and knowledge). In a 5 year study of new teachers of color, the teachers revealed they were unable to draw upon their own or their students' cultural resources fully to enact culturally responsive teaching (Achinstein & Ogawa, 2012). The participants shared that the standardization of curriculum and instruction and meeting testing requirements, and incongruence between instruction and the learning preferences and academic experiences of the teachers' community of students were examples of challenges described by the participants.

Other scholars have stated that integrating teacher education with discussions of beliefs about teaching and learning and reflecting upon the relationship between such beliefs and teaching and learning is critical in teacher preparation (Nieto, 2009; Allen & Labbo, 2001; Sleeter, 2001; Barton, 1999). Often the strategies used in teacher education can be described as add-on, immersion, transformation, and programmatic changes (Sleeter, 2001). In add-on courses, multicultural topics are included in the content of select, traditional certification course(s) or a course on multiculturalism is added as an option in fulfilling academic credits. In add-on courses, the topics on multiculturalism are often miscellaneous and are not fully integrated into the program experiences of the

preservice teachers. Immersion courses provide opportunities for preservice students to be engaged beyond class discussions in multicultural-related experiences. Transformation courses fully integrate multicultural education into the design of the course. Yet the greatest altering of teacher preparation occurs with programmatic changes, which include the integration of multicultural content in courses and National Council for Accreditation of Teacher Education (NCATE). Another key programmatic change is revision of admission requirements, which might, for example, select students to facilitate cultural and linguistic diversity in preservice cohorts.

Add-on courses and immersion experiences can cause cognitive dissonance for preservice teachers who might understand the need for culturally responsive teaching but do not recognize how it is integral to implementing reform-based practices (McFalls & Cobb Roberts, 2001). If immersions are not paired with multicultural methods instruction and thorough discussions of culturally related issues, then the learning and professional development expected may not result. Even programmatic changes are not practical for all teacher preparation programs, such as state sponsored university-based teacher preparation programs in which government and school policies and procedures have to be followed. The next section draws on three examples (field experience, science methods course, and inservice professional development) in order to highlight approaches and describe conclusions that arose from efforts to support teachers to transform their goals, content, and instructional practices to engage all students in their classroom, particularly marginalized students.

Roth, Tobin, and Zimmermann (2002) proposed coteaching and cogenerative dialogue as a model to prepare preservice teachers to teach science in urban schools. Preservice teachers work in the classroom with teaching partners (i.e., one or more mentor teachers and preservice teachers) teaching together and learning from each other (Tobin & Roth, 2005). With cogenerative dialogue, teaching colleagues share and discuss their understandings, experiences, and perspectives about the classroom activities and learning environment. Scantlebury, Gallo-Fox, and Wassell (2008) reported findings of a 3-year, longitudinal study on coteaching and cogenerative dialogue in an urban school. Interns and cooperating teachers taught science classes together, and participated in weekly seminars on teaching and learning with clinical supervisors, researchers, and university faculty. The researchers (Scantlebury, Gallo-Fox, & Wassell, 2008) concluded the preservice teachers: 1) created expanded social networks for professional development or multiple human resources to support their teaching and learning, and 2) practice in designing and redesigning teaching and classroom practices. Further, the preservice teachers reported they learned from one another and teaching colleagues the real challenges of the teaching contexts of urban schools, and developed new understandings about teaching and learning. In contrast to the Scantlebury, Gallo-Fox, & Wassell (2008) study, Mensah (2009) introduced a book club in a science methods course to engage preservice teachers in processes to become culturally responsive.

In the book club, preservice teachers read *Ways with words: Language, life, and work in communities and classrooms* (Heath, 1983). The preservice teachers were asked to reflect upon and discuss urban and rural schools and communities and how these

sociocultural contexts, including language and home culture, are related to teaching and learning and developing personal and professional connections with students and their communities. Mensah (2009) reported observing a shift in the preservice teachers discourse. At the start of the book club, the students reported that they did not see the relevancy of the text to a science methods course and the compatibility of discussions about science and diversity. At the conclusion of the book club, the preservice teachers reported that they were now more open to thinking about diversity and science instruction as compatible and how diversity, that of their students and their own, is related to teaching and learning. Further, the preservice teachers described broaden conceptions of diversity including social, political, institutional, and educational dimensions. Another approach conducted in a science methods course is the Drawing-Elementary-Science-Teacher-Ideal-Not or DESTIN (Mensah, 2011).

Preservice teachers' drawings of science teachers and their illustrations of science teaching were used to guide class discourse about preservice teachers' stereotypes of science teaching and learning. Class discussions focused on the nature of science, beliefs about science teaching, and role of science teachers. Mensah (2011) analyzed that the pre-drawings demonstrated minimal knowledge of diversity within science education and negative or stereotypical images of science and science teaching. Within the post-drawings the science teachers expressed beliefs that science teaching and learning builds on students' prior knowledge and experiences, is student-centered, inquiry focused, and includes collaborative learning. Further, the post-drawings included images of children with physical disabilities, darker skin tones, and girls and boys were depicted. Inservice

teachers in Johnson (2011) were introduced to the Transformative Professional Development model to encourage them to contemplate and attempt new theories and practices for teaching diverse learners.

Inservice teachers were encouraged to build relationships with teaching colleagues, university faculty, and communities to support their goals, content, and instructional practices to engage all students in their classroom. Further, the participants engaged in dialogue about high expectations for student success, and the reform ideal of science for all. Johnson (2011) reported that the inservice teachers described that they felt more comfortable with the teaching challenges of working with diverse learners and creative in seeking additional teaching and classroom practices to engage all students in their classroom. The strategies and methods discussed in this section were approaches for preparing teachers for the diverse classrooms they will serve. In addition to the discussion of how multicultural education and culturally responsive pedagogy impact science teacher preparation to teach diverse learners, the discussions within teacher education have been on approaches, such as urban education, used to describe teaching across student diversity.

Urban Contexts

The instruction typically observed in urban and rural schools is important for what it says about teacher preparation for diverse learners and the ways in which teacher education instruction is organized and implemented (Ladson-Billings, 1999). Specifically, urban schools are central to historical literature on teacher preparation because they are important sites in the differentiation of cultural diversity and focal

points for research on programmatic practices. Some educators (DeYoung, 1987; Ladson-Billings, 1999) have coined the typical pedagogical models as urbanized instruction.

Urban teaching strategies differ from attempts to (re)socialize students to mainstream behaviors, values, and attitudes and instead draw upon approaches that incorporate students' social and cultural backgrounds to facilitate learning (Ladson-Billings, 1999).

Some urbanized teaching strategies follow the cultural deprivation or disadvantaged model, which emerged in the 1960s. A central idea of this approach is that the home or community environment for specific groups of students is a culturally deprived experience (DeYoung, 1987; Hodson, 1993; Ladson-Billings, 1999; Parsons, Foster, Gomillion, & Simpson, 2008). A challenge appears for teacher preparation if teacher education and professional development is embedded in a culture and history of cultural deprivation or disadvantaged model (Cochran-Smith, 2004).

In summary, a review of existing literature linked to pre-service teacher preparation programs and professional development training for understanding and competently meeting the needs of a growing diverse student population require comprehensive and culturally responsive efforts and programs. Too often topics related to diversity are presented in limited and fragmented ways in small and specialized contexts, such as a single course or single field experience. Exposure for training may be confined to a single selected school setting, such as those placed in an urban or rural school community. Standards of the course and field experience expectations for teacher engagement in professional development on student diversity and topics of multicultural science education and culturally responsive pedagogy are not consistently supported by

current teacher education. In addition, the nature of science and how it impacts science teacher preparation and may contribute to challenges and opportunities to teach science to diverse learners are ideas not fully developed in teacher preparation models.

Theoretical Frameworks

A theoretical framework functions to conceptualize the epistemological, ontological, and methodological thinking (process) of the researcher, and provide a structure and scaffold for the research (Merriam, 2009). Further, a theoretical framework is a philosophical entity formed by the concepts, assumptions, and beliefs, which support and inform the research (Creswell, 2007; Maxwell, 2005). The theoretical framework that guides this study is supported by a social constructivism theory and Bronfenbrenner's bioecological model (Bronfenbrenner, 2005).

Social constructivist theory is an apt theoretical framework for this study. Supporters of this perspective believe knowledge is influenced by interactions and the social contexts in which they are embedded (Southerland & Gess-Newsome, 1999; Vygotsky, 1978). Through personal experiences, cultural affiliation, historical, and social contexts, learning occurs and conceptions are shaped (Denning 1992; Giroux & McLaren, 1994). Matthews (1998) distinguishes three forms of social constructivism. Educational constructivism has origins in theories of learning and development. Proponents of philosophical constructivism consider beliefs and perceptions to be dynamic constructions of actions and experiences. Sociological constructivism is associated with the sociology of scientific theory. From a sociological perspective, group beliefs and interactions consciously or unconsciously shape the construction of scientific

understanding (Matthews, 1998). Kim (2001) and Gredler (1997) posit that transactional or situated cognition is a perspective of social constructivism and includes the natural environment as a contributing factor offering insight on learning. The authors' perspective spans beyond more commonly used descriptors of environmental contexts to consider human interaction with nature.

Bronfenbrenner's bioecological model incorporates the biological and ecological, to consider individual characteristics and their interplay with environmental experiences (Bronfenbrenner & Ceci, 1994). In his seminal work, Bronfenbrenner (1979) presented the notion that "context matters" in development and learning. Perceptions, thoughts, and beliefs, as Bronfenbrenner would argue, evolve as a function of a person's exposure to and interaction with the environment (Bronfenbrenner, 2005). Lewthwaite (2011) refers to the bioecological model as a systems theory considering the complexities of relationships and interactions and the multiple levels that influence them. Interactions between individuals and their environments dynamically contribute to the outcomes of development and learning. Loxley, O'Leary and Minton (2011) describe the bioecological model as learning and knowing which occurs in a variety of social relationships and contexts. Gardiner and Kosmitzki (2008) assert the bioecological model incorporate the role of culture as a contribution to the nested level of influences. These authors assert that the role of culture is essential for understanding the contributions and complex processes involved in learning and development.

Social constructivism and bioecological models serve as key frameworks for guiding and support the essence of this study. They address the importance of contexts

and the social interactions and constructions that emanate from them. Teachers learn through and are influenced by multiple contexts (i.e., family and significant others, neighborhood/community, cultural, historical, and institutional) in the evolution of their own development and learning. Consciously or unconsciously, they construct their own meaning from these interactions and experiences, which shape their worldview and contribute to and guide their values and beliefs about teaching. Further, it is posited that by self-awareness or critical reflection and self-reflection teachers will develop emancipatory knowledge. Emancipatory knowledge is self-awareness or critical reflection and self-reflection of themselves (Cranton, 2002), which is an important part of teachers' learning process and professional development. The development of emancipatory knowledge is an important process of learning about teaching, specifically for each teacher to better understand her teaching practices. Further, with critical reflection teachers would aim to rethink the social forces and institutions or systems that influence and shape teaching and learning (Kerber & Cranton, 2000).

Conclusions

The literature review focuses on core topics related to this research study: 1) context of the study and the rationale for studying effective teacher preparation in science education; 2) overview of the research on patterns of teacher preparation include multicultural science education and culturally responsive pedagogy; and 3) information on the nature of science. The literature review is critically important in addressing the research questions because it points to the forms of knowledge (conceptions of diversity and what and how to teach science) that is understood to be a central aspect of science

teaching and teaching diverse learners. The traditions in teacher preparation reflect part of the support structure of science teacher preparation. Juxtaposed is a multicultural education perspective, which provides elements of the history of teaching diverse learners and the skills and knowledge essential to effectively teaching learners of all cultures.

The researcher has developed four assertions by abridging the key ideas from the literature review. First, there are different ways of conceiving and organizing teacher preparation, reflecting views of teaching and learning to teach and different orientations to the preparation of teachers for diverse learners. Second, there are tensions in science education regarding scientific epistemological views, reflecting key differences in core values and worldview, and essential components for guiding instructional practices for diverse learners. Third, there are disconnects between theory and practice of approaches to prepare teachers for work in urban contexts and meet the needs of diverse learners. Finally, there are gaps organizationally and conceptually between science education and culturally responsive pedagogy. Chapter Three takes the reader through the research design, including restating the questions that organize the study. The theoretical framework is summarized and the methodology is outlined. A description of the participants, data collection and the process for analysis is presented.

Chapter 3: Methods

Introduction

As previously stated in the introduction, the purpose of the current study is to explore and share findings based on in-depth interviews with six study participants and to use their insights to contribute to the emerging body of literature on teaching science to diverse learners. The expectation is this study of teacher perceptions will contribute additional insights for preparing teachers to engage diverse learners in a manner that connects science learning to their daily life experiences and support teachers' efforts to reach, teach, and mentor all students in their classrooms. Again, the following research questions are addressed in this study:

1. What are science teachers' conceptions of diversity?
2. How do science teachers describe their knowledge of teaching diverse learners and the resources they use to guide their understanding?
3. What types of teaching strategies do science teachers use to reach and engage a diverse population?

Research Design and Theoretical Frameworks

To address the research questions, the researcher employed a qualitative study methodology. According to Denzin and Lincoln (2005) qualitative research is the design and construction of scholarly knowledge through interpretative, naturalistic approaches. From the perspective of Denzin and Lincoln (2005), this means that social and human phenomena are studied in context and made sense of, or interpreted through the meaning-making of the study participants. Creswell (2007) posits qualitative research reflects

assumptions, one's worldview, or a theoretical lens inquiring into the meaning of social or human phenomena. Similarly, Merriam (2009) states qualitative research is a richly descriptive, emergent and flexible inquiry of the meanings participants have constructed. Hatch (2002) describes qualitative research as a basic set of beliefs and worldview or epistemology and ontology that informs methodology and guides actions.

Understanding of the researcher's philosophical orientation and the belief, values and assumptions that guide the research process is crucial. This understanding and awareness is especially salient for considerations related the nature of reality and knowledge and the implications of a holistic description of the study participants and the settings in which the studied phenomena occurs. A review of qualitative research approaches offered a foundation for determining the design and choice of research methodology. The philosophical stance of the researcher must be thoughtfully examined and considered to ensure appropriate alignment with the research design and methodology for addressing the study questions and guiding the research process.

For qualitative studies the process involved is continuous; each step of the process informs subsequent phases. Since this study seeks to gain meaning from the perspective of study participants, capturing their voices and the ways they construct meaning of their experience is important and allows for a complex description and interpretation of their experiences with the opportunity to gain unique and new perspectives. In contrast to quantitative methodology, qualitative research may describe phenomena with more depth for understanding with the intent of capturing the construction of participants' meaning not fully understood using a more structured design (Strauss & Corbin, 1998; Lincoln &

Guba, 1985; Stake, 2005). Another contribution of qualitative research is the theoretical inquiring of social or human phenomena and meaning-making of individuals or groups (Creswell, 2007).

A theoretical framework functions to conceptualize the epistemological, ontological, and methodological thinking (process) of the researcher. Major authors in the field (Anfara & Mertz; 2006; Hatch, 2002; Merriam, 2009; Patton, 2002; Stake, 2005) have written about the intended purpose of qualitative research and theoretical frameworks for understanding how knowledge is constructed and linked to methods, insights into previous work connected to the research topic, and questions that can be explored. Theoretical frameworks provide a structure and scaffold for the research (Merriam, 2009). Maxwell (2005) and Creswell (2007) describe a theoretical framework as a philosophical entity formed by the concepts, assumptions, and beliefs which support and inform the research. The theoretical foundation that guides this study is supported by a social constructivism theory and Bronfenbrenner's bioecological model (Bronfenbrenner, 2005).

The theory of social constructivism is a key element in examining the learning process and will be discussed in the section that follows. Additionally, a bioecological model offers guidance and insights about learning as a developmental process and underscores the role and importance of context and the dynamic nature and influence of relationships and interactions on multiple levels. Even though the theoretical frameworks were introduced in Chapter 2, social constructivism and the bioecological model will be

discussed in this chapter as both a philosophical and methodological background to a qualitative study.

Social constructivism is a theoretical perspective that features the social contexts and interactions that occur within them. Supporters of this perspective believe knowledge is influenced by these interactions and the social contexts in which they are embedded (Southerland & Gess-Newsome, 1999; Vygotsky, 1978). Through personal experiences, cultural affiliation, historical, and social contexts, learning occurs and conceptions are shaped (Denning 1992; Giroux & McLaren, 1994). Matthews (1998) distinguishes three forms of social constructivism. Educational constructivism has origins in theories of learning and development. Proponents of philosophical constructivism consider beliefs and perceptions to be dynamic constructions of action and experience. Sociological constructivism is associated with the sociology of scientific theory. From a sociological perspective, group beliefs and interactions consciously or unconsciously shape the construction of scientific understanding (Matthews, 1998). Kim (2001) and Gredler (1997) posit that transactional or situated cognition is a perspective of social constructivism and includes the natural environment as a contributing factor offering insight on learning. The authors' perspective spans beyond more commonly used descriptors of environmental contexts to consider human interaction with nature.

As discussed in Chapter 2, Bronfenbrenner's bioecological model incorporates the biological and ecological, to consider individual characteristics and their interplay with environmental experiences (Bronfenbrenner & Ceci, 1994). In his seminal work, Bronfenbrenner (1979) presented the notion that "context matters" in development and

learning. Perceptions, thoughts, and beliefs, as Bronfenbrenner would argue, evolve as a function of a person's exposure to and interaction with the environment (Bronfenbrenner, 2005). Lewthwaite (2011) refers to the bioecological model as a systems theory considering the complexities of relationships and interactions and the multiple levels that influence them. Interactions between individuals and their environments dynamically contribute to the outcomes of development and learning. Loxley, O'Leary and Minton (2011) describe the bioecological model as learning and knowing, which occurs in a variety of social relationships and contexts. Gardiner and Kosmitzki (2008) assert the bioecological model incorporates the role of culture as a contribution to the nested level of influences. These authors assert that the role of culture is essential for understanding the contributions and complex processes involved in learning and development.

Social constructivism and bioecological models serve as key frameworks for guiding and supporting the essence of this study. They address the importance of contexts and the social interactions and constructions that emanate from them. Teachers learn through and are influenced by multiple contexts (i.e., family and significant others, neighborhood/community, cultural, historical, and institutional) in the evolution of their own development and learning. Consciously or unconsciously, they construct their own meaning from these interactions and experiences, which shape their worldview and contribute to and guide their values and beliefs about teaching. In the next section that follows the interview as an approach will be discussed.

Interview

Creswell (2007) observes that interviews provide thick, rich data sets. As posited by Patton (2002) interviews are detailed descriptions of the participants' activities, behaviors, actions, and perceptions. Weiss (1994) describes interviews as access to settings that would otherwise be closed to researchers. Kvale (2009) sees interviews as a specific conversation or dialogue between the researcher and participant. He sees interviews as a way of capturing themes describing the daily lived experiences and perceptions of participants. One of his descriptions of interviews relevant to this work is the philosophical dialogue, a conversation between two people with the intent of understanding a given phenomenon. Further, he views interviews as the production of knowledge through working with words. The selection of interviews as a method of inquiry supports efforts to capture the perspectives of study participants in the teaching context. The next section describes participants of the current study and the selection process.

Participants

The participants for the current study are six former and current secondary science school teachers. Participants volunteered from a list of science teachers teaching in two local school systems. Additionally, teachers were recruited based on those whose name and email address appeared on their school website who I emailed and asked to participate in the study. Of the teachers approached, six volunteered to participate. Of these six participants, all were female. The ethnicities of the participants were one African American and five Caucasian American. Study participants completed their

teacher education preparation at the same state university located in the southeastern region of the United States. Some of the participants had additional education experiences. Two had experience teaching undergraduate science courses. One had experience teaching an undergraduate teacher education course. A participant worked in science curriculum and development for a local school system. Another participant had formal training in urban education. Similarly, one teacher participated in professional development with a program designed to motivate and support students facing economic challenges to aspire to attend postsecondary education that is referred to as the pseudonym Project Success in this study. Project Success partners with local school districts to create a support system encouraging students to participate in college. Compensation was not provided for participation in this study. The teachers' participation required an in-depth interview. The interview process is discussed in the next section.

Data Sources

The guidelines and forms for research activities involving human subjects was followed as outlined by the researcher's university campus Institutional Review Board (IRB). Data were collected through an interview process. Prior to the development of interview questions for this study, a pilot study was conducted. The pilot study was primarily designed to inform and serve as guidance for the researcher to: 1) establish the research questions, 2) develop and test the theoretical alignment of the research methods, 3) check for questions that fail to address the research questions, 4) assess whether the research methodology is an appropriate process to collect and analyze data, and 5) re-word ambiguous interview questions and interview questions that do not generate

thoughtful responses. The pilot study also served to refine the interview techniques and process, note-taking, active listening and responding skills of the researcher. None of the participants in the pilot study participated in the current study.

For the current qualitative study, one formal interview with each of the teachers was conducted. The semi-structured, open-ended interview questions were designed to collect thoughtful responses that would lead to a greater understanding of teachers' conceptions of diversity, their own science teaching strategies and how their students learn. All interviews were conducted at sites chosen by the participants. Prior to the interview, the participants were briefed on the research topic and the purpose and nature of the interview process. Pre-interview procedures also included a detailed discussion with the teachers on the confidentiality of the process and their interview responses.

Each interview began with an introduction to the study and the participant sharing her decision-making process that lead to becoming a science teacher. Each participant was asked permission to audio tape the interview. Audio tapes are an accurate method to record the content of the interview. An interview guide of questions was used (see appendix for a copy of the guiding questions). The guiding questions were the primary questions and provide a focused, coherent inquiry. Probes were an important part of the interview process to clarify interview responses and bring forth more details of the participants' thoughts, actions, and experiences. While interviews were being conducted, no problems were encountered that would affect the quality and quantity of the interview responses or the trustworthiness of the results. The participants were thanked for their participation. After all interviews were completed, each interview audio-tape was

submitted to a transcription service by the researcher. Each transcript was carefully checked for completeness and consistency. Although none of the participants chose to do so, they were offered the opportunity to review their interview transcript. The data obtained from the interviews were categorized, coded and an interpretative analysis was conducted.

Data Analysis

In Chapter 4, the findings are organized by research question and the related categories and themes for each question. An initial data analysis step involved the creation of a category system. After insightful review of the research questions, the researcher considered all the meaningful units of information or descriptive categories grounded in each research question. Further, the researcher developed thorough and higher levels of categories, because some of the initial categories were inadequate to offer meaningful and descriptive units. Categories were preset prior to a review of the transcripts, and did not emerge on their own. The categories for Research Question 1 are defining diversity, teaching philosophy, and multicultural discourse. For Research Question 2, inservice and professional development, classroom experiences, and science education literature and strategies are the categories. Research Question 3 had two categories, teacher-student interactions and curriculum and instruction considerations. By marking the interview transcripts in categories, a framework or conceptual structure to support and guide iterations of the interview transcripts and clarify themes in participant discourse was produced.

Berkowitz (1997) provided an apt description of the next step of the analysis of this research data: a pattern of multiple rounds of reading and rereading the transcripts. With each reading of the transcripts notes on observations such as patterns and key contradictions that could be useful for analysis, the researcher made notes on the transcripts. From these notes, themes emerged. The development of themes was an inductive, iterative, and reflexive process. Themes emerged that seemed immediately to capture a category related to the research question and essential perspectives of the participants. Other themes were structured after grouping of related emergent themes and after additional reading of the interview transcripts and reflection on the emergent themes. The researcher labeled all the themes using terms that described the observations made by the researcher or incorporated terms used by the participants. Further, the researcher continued to read and review the interview transcripts to make sure the identification, labeling, and organizing of themes was supported by participants' quotes.

The themes were used to organize and summarize the main ideas of the teachers' conversations to form an explanatory whole (Strauss & Corbin, 1998). The researcher assigned one or more themes to units of the interview text, and some of the themes were used repeatedly throughout the interview transcripts. In this way, the themes provide more meaning and help formulate greater understanding of the participants' interview discourse (Gubrium & Holstein, 1997). After developing categories and themes an in-depth analysis of contextual factors, the researcher conducted descriptive or explanatory inquiry of the phenomena (Yin, 2011). The analysis in Chapter 4 includes data from the

participants' interviews as they represent themes revealed during the data analysis, (Denzin & Lincoln, 2005).

Establishing Trustworthiness

The measures of trustworthiness and credibility defined for this study are: 1) review of the transcripts and data analysis for inconsistencies in the findings, 2) alignment of the findings to the theoretical frameworks of this research, and 3) examination of the authenticity in the portrayal of the contexts studied. A key strength of the data analysis was reading the transcripts for summaries and to check themes (Potter, 1998). Instead, credibility of the data analysis was produced by outlining narratives and reflective notes representative of the participant's accounts that address the research questions. For the researcher, the pilot study provided practice in checking the interpretation and analyses of data. The practice strengthened the researcher's interpretation and analyses of the current findings.

A measure of establishing trustworthy interactions between the researcher and the participants was the participants were not devalued and no personal criticism of their responses implied. The researcher discussed and sought understanding of the participants' perceptions and meaning-making and acknowledges contribution of their experiences. In addition, the researcher drew upon the culture, language, beliefs, and experiences of the teacher participants to facilitate the interview discussion and completeness of the participants' response to the interview questions (Lincoln, 1995). The researcher offered an opportunity for participants to review transcripts for accuracy, but none chose to do so.

Chapter 4: Research Findings

Introduction

As elaborated in Chapter 3, the researcher used a system of coding [] to organize the data by preset categories linked to each of the research questions. This allowed sections of the interview narratives to be viewed by and organized extensively by themes that emerged from the data (Merriam, 2009). Excerpts of the narratives that illustrate these themes are presented to provide more meaning and help provide greater understanding of the participants' interview discourse (Gubrium & Holstein, 1997). After developing themes, the categories and themes for each interview were organized and connected, and the analysis is outlined in this chapter.

This qualitative study was designed to examine perspectives shared by science teachers about their science teaching, student learning, teaching experiences, and their pedagogical practices for diverse learners. The focus of Chapter 4, findings from the current study, addresses three research questions: 1. What are science teachers' conceptions of diversity? 2. How do science teachers describe their knowledge of teaching diverse learners and the resources they use to guide their understanding? 3. What types of teaching strategies do science teachers use that allow them to reach and teach a diverse population?

Findings presented in this chapter represent a summary of the discourse, perceptions, and experiences expressed by study participants as conveyed in their own words. One-on-one in-depth audio-recorded interviews were conducted and transcribed verbatim. The findings are organized as categories and themes related to each of the

research questions. The organization of the chapter reflects, in general, the steps of the data examination. In the first section, the participants are introduced. Pseudonyms were used to provide a method of confidentiality and anonymity.

Teacher participants

Participants volunteered from a list of science teachers teaching in two local school systems. One of the school systems is located in the state's third largest city, which has a population of 178,874. The racial and ethnic makeup of this city is 76.1% white, 17.1% black, 4.6% Hispanic or Latino (of any race), 1.6% Asian, 0.4% Native American, and 0.2% Pacific Islander. Individuals reporting a multiracial background comprised 2.5% of the population. The second school system is located in a small city 20 miles from the first city. The population of the second city is 27,258 with a racial and ethnic makeup of 93.59% White, 2.95% black, 1.55% Asian, 1.38% Hispanic or Latino (of any race), 0.22% Native American, and 0.03% Pacific Islander. Individuals reporting a multiracial background were 1.14% of the population. The source for the population data is the 2010 census (U.S. Census Bureau, 2010).

The researcher interviewed Lisa at a local park on a warm, sunny day. Lisa teaches at East High School. The school's service area includes the most affluent city neighborhoods as well as apartment communities of subsidized housing. From her earliest memories, Lisa has always liked science. It is her love for science and outdoor activities that drew her to teaching. Lisa thought that by teaching science using hands-on activities and outdoor lessons, she could guide her students to love science too. It was very important to Lisa that her students learn science beyond the level of high school

science courses where “we had to write definitions to words, vocabulary.” She credited her parents with helping her understand that science is more than defining key concepts.

The next interviewee, Nancy, seemed to have no restraints in her responses. Nancy’s bubbly personality and youthful appearance do not hint that she has an extensive resume with the county school system and a great deal of poise. Nancy accepted an administrative position with the county school system as a supervisor of science. She taught science at East High School and was a science instructional coach. It is clear that she still identifies herself as a teacher, even though she is not currently teaching in a high school classroom. Nancy reminisced that she “had an amazing science teacher in high school” and that this teacher and her learning experiences in high school science “really impacted my life and it made me interested in science.” It was in high school that she decided to teach and to teach science.

An interview with Monica was conducted at Emerald High School. She is active in extracurricular activities and she is often at the school after the class hours to help with the step team. Emerald High is a county school system with approximately 74.3 percent of the student population described as economically disadvantaged. Monica completed her internship at Emerald High School and later accepted a teaching position there. She “wanted to be a science teacher because of my high school teacher.” Monica shared that her teacher “made science really fun” and conducted lessons and activities that made her students “very involved” in class. Monica decided to be a teacher as she was influenced too by her science experiences in high school. Her desire to teach science was confirmed when she began “taking some of the educational courses” in college, where she was also

exposed to research that “says that African-Americans or any type of other group that’s not Caucasian are doing really bad academically.” To Monica the message was that “African-American students need to see African-American professionals” in the classroom.

Kelly, who is full of energy and enthusiasm, teaches at Foothills High School in a small city. At the time of the interview, she had taught 14 or 15 years. Kelly began college as a pre-med major and her interest shifted to exercise science. She recalled “but my parents always said, even when I was a kid they’re like, ‘You’d make a great teacher.’” What she was certain about was that “I love science and I kept taking science classes and I knew it [my career would involve] some sort of science area.” As a result, she thought, “Maybe I ought to give that a go.” Even so, Kelly was hesitant to consider teaching because “I didn’t consider it to be very ambitious to be a teacher.”

Stephanie has taught high school science for about 14 years at Chapman High School and then “went on to the college level” teaching after accepting an adjunct position at a community college. Her teaching load consists of biological sciences courses, and she has also taught education courses for the college. When she first began teaching at Chapman High School, which was formed from three former schools with students from rural, urban and suburban areas, Stephanie found the school’s teacher and student population to be “a white bread little community, and no diversity.” She observed that during her teaching at the high school, the school demographics changed: “There was a lot of diversity, a lot of U[niversity] parents that were professors at U[niversity] that some of them were Israeli or some of them were Muslim – just everything ... the

community had a couple of housing projects that fed into it ...”. Before teaching, Stephanie initially wanted to be an audiologist and minor in speech pathology. She had completed graduate coursework and began to write her thesis before leaving graduate school to get “a job in the business world.” After six or seven years, she began to wonder “what can I do with the knowledge that I already have?”. And then I decided I can teach science.”

Elaine accepted a teaching position at MLK High School, which has a majority black student population. Elaine’s student teaching was also at MLK. MLK is a performing arts magnet school in the metropolitan area near the state university, but after the birth of her second child, she did not return to high school teaching. Elaine began a Ph.D. program while living in another state and then decided to complete a non-thesis master’s program. After Elaine and her husband moved, she completed her secondary certification to teach. Elaine shared deciding to teach science:

Let’s see – I was in grad school, thinking I was going to go into being a health professional and I was a graduate assistant and I really liked teaching. And so then I just decided I liked that better, the social aspects of it, a lot better. I love science, but then I could also do the social aspects. And I just loved teaching. And so since science is what I’m interested in I became a science teacher.

At the time of this study, Elaine had not returned to her teaching position at MLK but had become an adjunct faculty member at a community college.

Research Question 1 – What are science teachers’ conceptions of diversity?

Three categories, which were preset by the researcher, were used to organize the data for Research Question 1. The categories for the first research question are defining diversity, teaching philosophy, and multicultural discourse. These three categories

represent an initial coding strategy of the interview transcripts. From readings of the interview transcripts, themes or the key ideas expressed in the participants' conversations emerged. Excerpts from the interview transcripts reflect the themes that emerged and will be used to help provide in-depth understanding of the categories and aligned findings for each of the research questions.

Defining Diversity

Defining diversity refers to the combined characteristics that distinguish and connect individuals and groups. The category is examined in greater detail using the following themes: individual differences, categorical attributes, and pedagogical considerations.

Individual Differences

Individual differences refers to how the participants think about how students differ or the variations from one student to another on any number of characteristics, for example, in backgrounds, culture, ethnicity, interests, languages, and learning styles. Participants talked about students' individual differences when describing their conceptions of diversity. In the following excerpt, Monica discussed individual differences among students as any quality such as race and socioeconomic status that distinguishes one student from another student.

Diversity is really just being different. It's anything that would make you different from something, that's what I see it – it's your race, your social, economic, your class, just anything that you can separate yourself from another. – Monica

Similarly, Lisa discussed individual differences among students as socioeconomic status. Her conceptions of diversity also feature categorical (culture), as well as, pedagogical (ways students learn) descriptions.

When I hear diversity I guess I – my thing is I think reaching lower socioeconomic, having different views come in, that there are differences in cultures that we need to look at, different types of learning. I guess just that we're all unique and different, even as individuals. – Lisa

Categorical Attributes

For the participants, diversity encompasses a myriad of attributes used to describe groups of students. The excerpt example shows that Stephanie discussed four categorical attributes: race, religion, age, and background.

I think diversity is a multifaceted word because it's not only different races, it's different religions, it's different age groups, different backgrounds. And all that is a big topic called diversity. One thing I found that was kind of astonishing in the '90s is that still women had to be encouraged differently even to pursue science at all. And so that was – not only was I trying very hard to engage people that were on the fringes – I also wanted to engage those women, no matter what color, creed, whatever; I wanted them to be front and center, and then to have confidence in their abilities. – Stephanie

Central to Kelly's consideration of categorical attributes was the cultural context and racial diversity of the student population. She described diversity as,

It means that diversity can be anything that strays from what the mainstream of the school is, if we're talking about diversity in the school. – Kelly

Two different student populations represent Kelly's categorical distinctions. According to Kelly, one group is white and middle-class and the other group is comprised of those students that are not white and middle-class. She summarized the two main dimensions as,

So if you take [this town], [this school] is primarily a white, middle-class school. So anything that varies from that would be diversity. – Kelly

Nancy presented a different description of categorical attributes than discussed by Stephanie and Kelly. She debated aloud if she could fully embrace distinguishing groups of students by descriptions such as culture. This excerpt is an example of her discourse on categorical attributes,

I am saying, "I'm just one of these people that I just don't like generalizing a whole culture." I know there are patterns, but for every culture and for every cultural norm that you come up with there are exceptions. So I do kind of tend to lean more towards if we meet a kid where they are and grow them from there then – not that I ignore culture or ignore a person's historical race identity or whatever, but we've just become such an American culture that is – it's all interconnected anyway; you've got all kinds of people marrying other people that we're creating all these new levels. So then you can't really define what the culture is. I think by being able to appreciate the home life, the background, the kid and where they are then I think an individual learning preference, as well as appreciating and attempting to understand where they kid is and where they come from. – Nancy

Besides describing individual differences and categorical attributes, participants discussed pedagogical considerations of defining diversity.

Pedagogical Considerations

Pedagogical considerations refers to the perspectives held by the participants that teaching strategies are relative to student differences, in particular the ways in which the nature of the curriculum and instruction contribute to students' meaning making and learning. Elaine stated how pedagogical considerations emerged from the differing experiences she had with her students. She commented,

The definition of diversity would be having a variety of topics and subjects that were interesting to the students. Like for example when we studied genetics I tried to search online, since my classes were 98% African-American I tried to find videos that had African-Americans in them. And I really found that it made a

difference. Like if we watched a genetic video and it was about a genetic disorder that mainly affected Caucasians they were just like whatever, but if it was actually affect African-American students they would be interested in it. Sometimes I had to have them help me, "What are you interested in?" talking about topics. – Elaine

Lisa also noted,

I think it was getting them to do things like doing some labs and some hands-on stuff, and connecting it to the real world. There was a student who came into class saying, "I hate science; I'll never enjoy science." And at the end of the semester he had said, "You know, this was one of my favorite classes at the end because you showed me that science is not about just sitting here; it's about getting up and doing some stuff. And it does relate to my life; we do need to kind of know a virus is this and a bacterium is that." I think it was the real-life experiences he liked that I brought in some good things that he could relate to. – Lisa

Teaching Philosophy

The participants tied conceptions of diversity to their personal teaching philosophies. In Chapter One, teaching philosophy was defined as “assumptions, attitudes, beliefs, and practices” (Cochran-Smith, 2000, p. 83). In the following section, the findings for teaching philosophy are examined in greater detail using four themes. The themes are: 1) desire to teach; 2) supportive atmosphere; 3) social awareness; and 4) making a difference.

Desire to Teach

The desire to teach theme was related to why the participants are teachers. Teachers can be passionate about their strong desire to give back, preparing and mentoring students and fulfillment by their own lifelong learning and helping students to grasp concepts and complex ideas. Elaine stated a teaching philosophy that created the potential for a more engaging learning climate. She focused her philosophy to teaching on increased student participation and nurtured inquiry learning.

I think the best thing that I did – and I did it in all my classes, was that I planted peas in a cup and we watched them grow. And I would say that was a really big thing. I tried to do a lab activity every single day and that was always something – like I had a student that had turned nothing in for an entire semester, I mean for the first two weeks. And then we had a microscope out and he was like, "Can I look at the microscope?" And I'm like, "Absolutely." And then he did those, but he still didn't do any of his other work. But I'm like he still got something out of being in class, which is what was important. – Elaine

Lisa's love of teaching and learning motivated her attempts to foster her students' love of learning and science.

I think I really liked science from the beginning and I wanted to – my love of learning for that science, I wanted to share with students. I just enjoyed it and I wanted our society to be a little bit more literate in science and I wanted to give the students experiences in science that I never had when I was in high school. I think it was getting them to do things like doing some labs and some hands-on stuff, and connecting it to the real world because I think they had no idea that what we were doing was learning and that it was going to apply to them later on. I really think I connected it to their real life and it made them more interested or more motivated to learn. – Lisa

The excerpt examples reflected participants' desire to help students realize their own potential through the learning and modeling inside the classroom. Further, participants acknowledged and were sensitive to the role of teacher attitudes and expectations in teaching and learning.

Supportive Atmosphere

The participants expressed a commitment to the creation of a supportive classroom environment in which their students had the opportunity to learn and grow. Encouragement and mentoring were essential to Kelly's teaching philosophy. In addition, the interactions she had with students emphasized to her the importance of developing a supportive atmosphere for students' educational experiences.

Anytime you can make a kid feel like they've been a success in something where they thought that it was going to be a disaster and they are successful – truly successful. I don't mean like you helped them to the point where they had success but where you facilitate a little and they brought themselves along a lot; that, to me is big success. – Kelly

Components of a supportive classroom atmosphere are the attitudes and expectations of teachers. Stephanie's philosophy about teaching emphasizes the importance of encouragement and mentoring of students through her positive attitudes and high expectations.

So I was determined that everybody was on the same footing, I was just going to start out and I was just taking it for granted that they could learn. So I treated everybody the same – I didn't treat Little Johnny like he was mentally retarded. So when he sat in the back of the class in the corner I'd say, "Come up here; this is your seat on the front row." And I wouldn't let them sink into their stereotypes because I just assumed I could teach anybody. – Stephanie

Social Awareness

Social awareness refers to ways in which contextual influences including institutional context and learning environment influence teaching and learning according to the participants. Nancy expressed a teaching philosophy that addressed learning the cultures of her students, taking into account the social and contextual factors impacting each child's learning and achievement.

I've always prided myself on building relationships and so I knew that I had to connect with the kids – I just didn't know how because I came from such a different cultural world than they had. So I had to learn the culture and where my kids were, and then I had to try and help them see connections to science. – Nancy

Additional examples from the interview transcripts of the influence of sociocultural contexts were elaborated by Monica.

For my students, the challenges that we see is students not having a permanent home to sleep in; they're moving all the time. We have the challenge where they're getting abused at home. Some of the students are not even on their correct reading level, like they're just that far behind on their reading level. We have students that are homeless, sometime, that what do we do when we ask you to bring your stuff everyday and you don't even know where you're going to stay? I don't even know if I would come to school for the things they have to deal with. Some of them are the parents to their younger siblings because parents have to work, or they're single parent homes, their parent is incarcerated; the other one drugs; we seen a parent come in and I mean you just see the signs: they're scratching and all that stuff, that they're on drugs. So I mean it's just so many factors. So many. Since I know these challenges I just buy the material and just have it available for them. I give them pencils, I give them paper, binders – if I want a binder with dividers and they say they don't have it I give it to them. There is no point of fighting something that you know that you can't win. Just so a student won't fall behind or feel as they they're being singled out by things that they can't receive; you just give it to them. So that way I can continue teaching the way I would like to teach and the way I would like them to learn, and so we won't hold back our learning just because we don't have poster board for this or we don't have construction paper or a pencil; things like that. – Monica

The participants' discourse shows that making a difference is another theme expressed in their discussions about teaching philosophy. Both social awareness and making a difference are not neutral and apolitical and speak to interactions between teachers and students, and other sociocultural factors influencing teaching and learning. The participants' teaching philosophies are bound up with social awareness and making a difference and these themes reflect educational goals, and learning perspectives for personal and academic growth.

Making a Difference

With making a difference, participants' philosophies of teaching were not only supportive but also were meant to build a personal context – all those attitudes and aims that expressed the individual student's relationship with self and as learners of science.

With Monica's philosophy, the ideas about teaching and learning science were broadened to play a critical role in students' general beliefs about themselves. She expressed that all students need to have a strong sense of self worth and the inspiration and hope to work towards the skills necessary for life. It was her hope that she inspired her students.

Once I got in college and started taking some of the educational courses they allowed me to know that this was the right place for me because there are many books and so much research that says African-Americans or any type of other group that's not Caucasian are doing really bad academically. So I feel as though African-American students need to see African-American professionals. And you know I've always had support from my family at doing things that I wanted to do; my mom always motivated me to go over and beyond. And so just with her teaching me that type of attitude, that's what I did. So I think just me realizing that students just need patience to succeed in the class, and sometimes they don't know how to ask for help when they need help. I try to teach them self-responsibility. So I try to get them to realize that you have to want this for yourself, not your parents, not your teachers, not any other outside person. That's the only way you can be successful. So me being patient with them, it works a lot because it shows that, "Okay, I'm going to stick with you. You're not just going to think that you're going to act crazy or blow me off and I'm just going to run away. No, I'm going to be right there." – Monica

Stephanie's philosophy developed from her personal belief system, which directed her work among her students.

"What would Jesus do?" I'm a Christian and I really believe you need to live what you say you believe and I didn't want anybody to be off limits, I didn't want to exclude anybody. I wanted to draw them in, I wanted to do what I thought was the right thing, and I have a very keen sense of right and wrong.

Multicultural Discourse

For the teacher participants' conceptualizations of diversity to be understood, part of this means examining the participants' discourse on multiculturalism. The participants' discourse on multiculturalism provides a variety of perspectives on their

conceptualizations of diversity. The following themes emerged from their discourse: 1) social justice, 2) reflective practice, and 3) valuing students.

Social Justice

A critical element of the participants' multicultural discourse was social justice. Social justice is a philosophy conceptualizing teaching and learning for full participation of all students and applies teaching in the classroom to activism. For Stephanie, transforming social justice to teaching practice was a core idea of her discourse on multiculturalism, as revealed by the following excerpt,

And some of the teachers, I thought they were prejudiced, actually. But that didn't bother me. I thought, "It's about time. It's about time that we let everybody have the same chance." – Stephanie

Nancy mentions respect in her multicultural discourse, and how respect is important to establishing social justice.

I think number one is respect – that's huge. I know for example I had a young man who was very – well everybody knew he was a homosexual. And one of the terms – you know, that kids say all the time is, "Oh my gosh, that's so gay." Well that offended him. And we really had to address that. So I think going into it, if you can explain to students, no matter what their level of, "We're here to work together to get to this end, whatever your goal is for that class, and along the way we have to be respectful of each other and of each other's feelings. We have to be trustful, we have to be honest." It would have been, I think, a very different ending if he didn't say, "Hearing those kids say that," and I thought, "You know what? I never even thought about it," because that's not part of my culture. But building that trust with the student and knowing that that kid can honestly come up and say something to me like that, like, "Can we address this?" then I am able to address that so that we can be respectful of each other. So I think the honest, trust and respect are the three big key ideas that I would make sure that we had when defining our cultural population.

As this excerpt shows the complexity of the participants' discourse on multiculturalism, the theme of reflective practice, shows that the participants reflected on their multicultural thinking through interactions with others.

Reflective Practice

Reflective practice is thinking about what the participants do and how and why they do it. Also, how well it is working, and does it apply to teaching diverse learners. Nancy pointed to her intern's experience teaching diverse learners. The intern struggled with the concept of multiculturalism as a framework for her own teaching. In reflective practice, Nancy related her philosophy of multiculturalism to teaching practice.

An intern that we had at our school said to me one day, "Those students just didn't react to me very well because I don't act black." And that was her exact statement to me. And I looked at her and I said, "What?" She said, "Well you know I'm black but I don't act black." And I said, "Do me a favor, can you act purple?" And she went, "What?" "Well that's just – why would you act purple; that's just a color?" And I said, "Exactly; that's what you're telling me." – Nancy

To encourage reflective practice, Elaine offered the following:

I think the biggest thing is to make sure that teachers are being placed in environments that are not just rigidly the same as their background. And it doesn't necessarily have to be by ethnicity but it's like I think it would be good to go out to a rural school if you grew up in the city, or if you grew up in a rural area to go into a city school, to just experience something completely different in students that are different from you that could give you that perspective. – Elaine

For the participants, discourse on multiculturalism required thoughtful reflection.

Another theme in the multicultural discourse of the participants is the importance of knowing students and their learning interests and needs.

Valuing Students

A key aspect of their multicultural discourse is that teaching and learning should be relevant to the lives of students and should reflect their ways of learning as well as their sociocultural backgrounds. Lisa described her understanding of multiculturalism as the use of teaching practices with the goals of motivating student interest in science and engaging student participation through their learning styles.

I think it means that you search out techniques on how to reach different types of learners, or you come up with different ideas or to reach and to motivate the students and to reach and make the science education something they do want to wonder about, that they are motivate about, that they're motivated to learn it. I believe in general just to make them kind of lifelong learners, to make them want to learn and want to have an education, 'cause I don't think that they see that a lot, or my idea. Some cultures, maybe, or some students aren't used to valuing education. – Lisa

Nancy also commented,

I know that people say, "Oh, we've got to teach to the norm," and my question always is, "Who is Norm?" I mean who we define as this? I think America has prided itself on being the melting pot for a very huge reason, and I feel like sometimes we try and standardize so much of it in our education to say, "Well I'm teaching this and I'll throw in a few African-Americans" during Black History month, "and then I'm going to call myself a multicultural teacher." But that's not really the case. There are challenges with women in science, there are challenges with other cultures – all cultures being engaged in science. And I think sometimes science is such a weird thing because people are like, "Oh, you're smart." That's why you're in science, and if you're not smart you go to another subject. I'm like, "It's not the case; anybody can succeed at this if you put your heart and mind to it." – Nancy

Valuing students grounded the participants' discourse on multiculturalism. For Monica, Stephanie, and Elaine expressed the importance of knowing, teaching, and engaging every student and creating a learning environment encouraging student participation.

Multicultural education I feel as though what they're trying to do is have facts or subjects that will reach all cultures, make sure that you learn about all types of cultures, and at the same time find teacher strategies that will reach all type of cultures. – Monica

I just think that's teaching everybody; that's multicultural because you're going to have people from different backgrounds, different learning abilities, different learning styles – there's just so many different things that add into that. And yes, you do have to appreciate culture, and I think anybody that says culture isn't a factor in group dynamics and whatever, I think they're crazy because it definitely is and I always tried to bring culture into whatever it was we were studying. – Stephanie

Multicultural education would be topics and role models that are reflective of the student's ethnicity and background, along with different ethnicities and backgrounds. One big thing for me was one of my first semesters went on a – when I was pre- being an intern, so the semester before I went on a field trip and we went to the Smokies. And at the beginning they had this little video of people who visit the Smoky Mountains. And in that entire video – and I had – we had 100 African-American students – there was not a single African-American in the entire video. And it was like I had never thought of anything like that before, that it was weird that they had every other group represented because I guess they were trying to be – they had like Asian families and Caucasian families and disabled, and I thought that was very strange. And I remember thinking, "I wonder how they feel, like this is a welcome video, but there wasn't a single person in the video." But also my education at UT because the lead instructor was really – that was one of the reasons that she – it was really important to her and that's why she wanted to place student teachers in different – in the inner city – or, I guess that's what they call it, but the inner city schools. So that was part of it. – Elaine

Kelly was aware that not all classroom environments are inviting, reflective, and actively engage all students.

I think about kids that are not brought up in this community that come in from somewhere else – from the culture of a different place. I know people define that in terms of ethnicity more than anything but I'm just thinking our kids, whether they're white or they're black, or even if they were – I don't know, Hawaiian or they came in from – if they grew up in this area, they'd know. I mean they hear their teachers, they hear the – it may not be their family but the culture of the school – they know the culture of the school. – Kelly

Kelly found her conceptualization of multiculturalism and science education shaped by life experiences that offered limited opportunities for her to observe and discuss multiculturalism from multiple perspectives.

I think it just might be high school. I don't know. That's hard for me to say – I'm white, you know what I mean? So my experience has always been as a white woman walking around in a very white world, walking around Foothills High School. I don't see our kids of different ethnicities having too many problems but they do clump up together some. – Kelly

The second research question and findings will be examined in the next section.

Research Question 2 – How do science teachers describe their knowledge of teaching diverse learners and sources that guide their understanding?

The categories for Research Question 2 are 1) inservice and professional development, 2) classroom experiences, and 3) science education literature and strategies. These categories, which were preset by the researcher, were used to organize the data for Research Question 2. The three categories represent an initial coding strategy of the interview transcripts. From readings of the interview transcripts, themes or the key ideas expressed in the participants' conversations emerged. Inservice and professional development is the first category to be presented.

Inservice and Professional Development

Inservice and professional development refers to activities to enhance skills and knowledge. Three themes emerged from the data related to inservice and professional development, including 1) extracurricular scholarship; 2) teaching-related knowledge; and 3) high school and college experiences.

Extracurricular Scholarship

The participants' knowledge of teaching diverse learners and sources that guide their understanding is a complex process that encompassed forms of learning that were not formally included in the professional development opportunities offered by their school or school system. Participants shared that networking with other teachers and development-while-teaching (inservice) were utilized professional development opportunities. Specific examples of the participants' extracurricular scholarship were participation in Project Success, completing the application process for national board certification, and attendance at professional meetings and conventions. For example, Elaine's professional development primarily consisted of training through Project Success.

Well we went through a lot of seminars at AE, where we had this whole Project Success that came in and talked about diversity and learning, which included all types of teaching styles – I mean learning styles and things like that. – Elaine

She and her teaching colleagues participated in Project Success, because

I would say it's because our school population was African-American and at least half the teaching staff wasn't African-American. So that would be why it was chosen. And it was an inner city school, so a lot of times they were intermixed. – Elaine

Nancy expressed that a number of factors shaped her knowledge of teaching diverse learners. One of these factors she shared was her national board certification application process was a key factor shaping her understanding and perspectives on teaching and learning.

I'd gone through the national board certification process and I'm a nationally board-certified teacher. – Nancy

Further, Nancy found that networking with other colleagues including teachers and graduate school peers and mentors was an essential part of her professional development.

As she pointed out,

A lot of the parts that contributed to that were my experiences in the classroom, and support from my colleagues that I taught with, both at my high school and that I had made network with throughout the system, and then just really some of the connections of people that I had met along my path of going back and getting an urban specialist degree and going back and getting my Master's through the university and just I guess really having some people believe in me and push me to new level. – Nancy

Stephanie indicates that there is a great deal to learn at professional meetings and conventions. She found that professional meetings and conventions enhance reflection on teaching practices and methods, and allow her opportunities to participate in professional discourse with a community of science educators.

The reason I like to go to those conventions is because – it could be statewide or even region wide -- but just to get a bunch of people in a room and talk about different students you had and what worked with them. I would take copious notes; I would write down everything. And I would go back and deliberately try it. And going to these conferences, like NABT or NSTA – hey, I would always go to one of those every year because I got so many ideas from other teachers in different parts of the U.S. – Stephanie

Another theme of inservice and professional development is teaching-related knowledge.

Teaching-related Knowledge

Teaching-related knowledge includes professional insights that are relevant to the teachers' professional development. Monica's observation was that her interactions with her students helped develop her professional knowledge. She expressed that feedback

with her students is needed in order to embrace challenges and opportunities of teaching across student diversity.

I asked them what they want to do in class; I actually just ask them why, "Okay, so what am I doing wrong? Somehow my Master's degree did not help me figure out how to teach you. So let me know." And I always tell my students – I ask them like, "Did you like this way of taking notes? Is there another way that we've taken notes before that would help you better?" So it's all about the students' input. And all of the students learn in so many different ways. So their input I make sure I teach the same content in different ways to make sure I hit everybody the way they learn. It is. And they will speak up, like if you ask them they will speak up. Sometimes teachers are so stuck in their ways, and especially if they teach for a long time – and I just hope I'm not this way, just, "I got this plan, this this this and that; I'm going to do it this way," that they don't want to hear how the students learn. And you know, everyday things are different. Now, you know, you got to put in blogging and on the internet, you know, just stuff that they do every single day, the way they text; you just got to relate to them. So just keep updating their strategies and making sure you connecting to the students. – Monica

Participants voiced concern about how current inservice and professional development related to national and local curriculum and instruction regulations and educational outcomes. For Kelly, curriculum and policy regulation were important characteristics, albeit negative, contributing to her professional development.

It's just changing; I can't say it's been a positive change at all. It sounds like it should be a positive change. If you look at it on paper, theoretically it looks positive, it looks good. It's kind of like the whole No Child Left Behind: of course, no child left behind – who doesn't want that? But the fact is when you step into an actual working classroom with the kids that are in there, you can only, as a teacher, work with what you've got. So changing the standards, what it did – and I think I could speak for all my colleagues on this in my department and say that what it did was it made us focus more on the standards and we have had to be get away from some of the other things that we did in biology that really made that class cool. – Kelly

Kelly added,

Back when I first started teaching, too, we had lots of professional development, and our school system paid for us to be able to go to NABT or to NSTA and that

– we were using Eisenhower grants at that time to do that – so I guess it wasn't the school system, it was Eisenhower grants that would pay for our flight and pick up our hotel room, and there's none of that money available to us now. So what we see in terms of science, the professional development is that very few of us get any. – Kelly

Stephanie found funding, curriculum standards, and policy regulation affect the ease or difficulty of the professional development of teachers.

But there was woefully little preparation for teaching any special needs child. But as far as support: I just really felt like even when I was in college; and I was a later graduate, since I was older – that they did not do anything to help me teach students of special needs. Now I had a little better training than some of the others because I worked in a birth defect center, for a long time, but I felt like somebody needs to come and show me what I need to do so that I can really reach these people because I want to do the best I can for them but I don't know that the best is because I've never been taught. And I would have liked – especially teachers at our school who sit off in their offices and fill out paperwork and we never saw them. I know they supposedly had a class but I never saw them in class either. I just felt like they needed to be visible; they needed to be people to actively work in our classrooms to help us with our students. – Stephanie

The participants discussed experiences in school they related to their professional development and thought to enhance their skills and knowledge.

High School and College Experiences

High school and college experiences were firmly rooted in early ideas about teaching and learning. A strong element underscoring Lisa's professional development was both her high school and college science classes.

So I guess a mixture of my experiences – I was a high school student – my experiences growing up: I was always outside and liked it. And I think now we've gotten away from – we're in a little school room, like a little prison and we don't get out and do things to let them know that science is about getting out and doing that stuff. I also think that – at the University I took all science classes; I really thought that getting those kids out there in the environment, doing something, got me interested; I'm sure it got other people hooked. – Lisa

In contrast, Kelly shared that her field experience was disappointing to her. Yet, she was able to learn from those negative experiences ideas about best (better) teaching practices.

And at the time I took the teacher preparation I did a field experience with somebody – I had to go do an observation or somebody at a high school in another city and it was horrible. The teacher I was placed with, the kids slept and she worked at her desk for the whole class; she did no teaching at all. And I sat in there mortified. – Kelly

Classroom Experiences

Classroom experiences relate to developing knowledge of teaching diverse learners and sources that guide their understanding. The participants' related knowledge of teaching diverse learners to classroom experiences, which were sources that contributed to the development of their understanding of teaching science in multicultural settings. The following excerpts show what the teachers say about their classroom experiences and how these experiences were informative in learning how to teach. The participants' teaching experiences were an ongoing process of learning that crossed all aspects of teaching and learning. Student engagement and participation represented a critical theme within the category of classroom experiences.

Student engagement and participation

Student engagement and participation means that teachers engage with students and get them to participate in activities.

Well once we became a Project Success school we were really – every time we had in-service day we were in some type of learning seminars. And I wouldn't say that they were directed at multicultural education but there was some aspect of the seminar that usually addressed that. Most of it was about how to be – to deal with a lot of the social problems we had at our school, and it would include that, but include some multicultural education. In some _____, kind of about what's going on in the community and things like that. – Elaine

Elaine participated on a school committee reviewing annual yearly report progress data for her school. She learned,

Well one of the big messages we always got is if the student they found in studies that a students are engaged in school they're more likely to come to school. So the idea is that they could get engaged in a band or football or some kind of extracurricular makes them more attached to the school, therefore it makes them want to come to school more. – Elaine

Elaine discussed how her work on the school committee shaped her teaching experiences.

If you can find a way to get them engaged in the classroom they're more invested in it. So – like I had a bathroom manager who basically signed people in and out and they took their job pretty serious. So it was sort of something I didn't have to deal with and that it also made them feel like they were part of the classroom, which is the idea behind it. Like the more that they feel engaged the more that they'll come to school and things like that. And then getting the community engaged; they had community forums where people could come and talk and we went out into the community. What we did – and I did it every single time – at the beginning of the school year, for all the freshman, we visited their home on a Saturday and it was called "In the Community." – Elaine

Lisa found that instructional flexibility was essential to increasing student engagement and fostering positive attitudes toward science. For her,

It was frustrating. I would try to engage all my students, like I would try to start a relationship with them, so when they were just sitting there not doing anything I'd walk up to them and say, "You know what? You're not participating in this activity; how do you think we could do it different?" And they would – I know I had one student you said, "Why don't you let me make a rap song, or just let me make up a song?" So he got his choice of making up his song to mitosis. And another student wanted to draw, for me, phases of mitosis or do a cell project; she was more artsy. I think when I started a good relationship with my students at the beginning, like knowing what they like to do and the ones that were antischool I try to kind of tap into what they would like, like whether they were more artistic, whether they were more musical, whether they were more jump around, where they stood up and they had to act it out. – Lisa

Nancy found that learning about her students' home culture and making connections between science and their daily life experiences was essential for student engagement in science.

When I came back and started my teaching career I ended up at a high school, which at the time had five project areas that fed into it and had a couple of group homes that fed into it. It was a completely different culture than what I was used to. So that became a lot of my growth that first year was figuring out ways in which – How can I connect this to your world, or show you ways in which this impacts your life? So for me it was first learning about their world and culture. I don't understand what it is to be taken as a ward of the state and live in a group home; I don't understand that. I've never had to deal with it, thank goodness, but when you're trying to figure out or you're living in lower poverty and you have to figure out where your next meal is coming from, that I didn't get either. So I had to learn the culture and where my kids were, and then I had to try and help them see connections to science. – Nancy

For example, Monica relayed a story of patience and communicating with students. She shared in greater detail, the following narrative:

I had a student and he just would not do work. So what I ended up doing every quiz or every assignment I would just sit right there beside him and just wait on him to do anything: to ask me a question, to do something. And one day he did: he asked me a question and I show him step-by-step how to do it. And some students just need that extra attention because they feel as though they can just slide under the radar and I make sure I call all my students and when I notice there's some of them a little off track I start getting on them, calling them. I feel as though the students have become accustomed to telling a teacher, "I don't have that answer," and the teacher like, "Okay, I'll move on to the next student," and don't wait for the answer. I'll wait. I'll let them take out their notebook, look through their notebooks and find the answer, but I'll wait for a mere answer and they know I will wait, so they just go ahead and do it, don't even fuss and argue with me. So it's just all about the patience with the student because once you let them get away with, "This is going to always be the answer: 'I didn't get that; I didn't get that.'" – Monica

In consideration of curriculum influences, Kelly found the No Child Left Behind policy a barrier to effective teaching and negatively impacted her teaching experiences.

If you look at it on paper, theoretically it looks positive, it looks good. It's kind of like the whole No Child Left Behind: of course, no child left behind – who doesn't want that? But the fact is when you step into an actual working classroom with the kids that are in there, you can only, as a teacher, work with what you've got. So changing the standards, what it did – and I think I could speak for all my colleagues on this in my department -- was it made us focus more on the standards and we have had to get away from some of the other things that we did in biology that really made that class cool. – Kelly

Stephanie has learned from her teaching experiences to value each of her students and that every child should have good instruction regardless of their ability level.

But one of the things I made it a point to do when I taught biology is even if they're not the cream of the crop, they need to learn too. And I taught some of the kids that other teachers said, "Well I wouldn't teach that kind of kid for anything in the world." And I thought, "Well, kids are kids." So some of my greatest successes were the ones that everyone had written off as being dumber 'n heck, you know. – Stephanie

Science education literature and strategies

The final section focused on the ways the participants perceived science literature to contribute to their professional knowledge and supported their work in teaching science. The participants' conceptualization of science education literature and strategies included the following themes: 1) coursework and preparation and 2) intellectual interest.

Coursework and preparation

When discussing science literature, Lisa recalled little specific guidance from literature facilitating her professional development. Although exposed to science education literature, Lisa had limited recollection of what they were or how they related to multicultural education for science.

This last year I did not have any experiences in that. I think just from my own, I just – for my own experience I'm like – I guess this whole multicultural thing is just new to me so I haven't explored any books that I can think of over the top of

my head. When I was in science education at the University we did read a lot of books but I can't remember offhand what they were, and I think maybe one book was on multicultural education science and right now I just cannot think of it. – Lisa

In the transition from preservice to inservice, Lisa recalled less exposure to central concepts and theories and education phenomena through reading research articles, curricular articles and literature reviews. Some participants positioned themselves to learn through post-baccalaureate studies. Nancy described a special program at the university with emphasis on urban education and the value of going back to apply her graduate work to her classroom teaching and to motivate and challenge her students.

During urban specialist time, for example, we were challenged with ways in which we challenged with our thinking patterns, the way in which we presented material in order to go back and work on our classroom, and just challenging us to push to new limits for our kids but to think about it in new ways because I think sometimes teachers get in and teach the way that we learned best and not necessarily the way that all students learn best. – Nancy

Preparing for the national board was part of Nancy's inservice development. She gives really strong credit to her national board preparation and the reflection and diverse ways of teaching for different student performance that she learned. Nancy saw it as a major contribution to her growth as a teacher and the ways it contributed to successful student learning.

So doing that helped me, but really with national board, that was huge because we really had to take and there were different components to it and one of the components was we took two students: a higher-performing student and an average to low-performing student and we literally had to showcase how the different ways in which we taught impacted growth in this child, and to really take the time to sit down and type out 25 to 30 pages of reflective thinking. You know, as a school teacher you don't typically have that time to do it and I really had that time to sit down and look at it and I was amazing at how much growth that my students had had in terms of successes and they all didn't learn the same

way. So that just really went back and validated by I used a variety of different teaching styles. – Nancy

Monica's perspective on science education literature was that she better understood the influence of role models and her sense of validation about the role she could play with her students.

Once I got in college and started taking some of the educational courses they allowed me to know that this was the right place for me because it's so many books and so many researchers say that African-Americans or any type of other group that's not Caucasian are doing really badly academically. So I feel as though African-American students need to see African-American professionals. – Monica

Stephanie learned from the negative models of teaching, which she described as an interruption in her learning. She felt that some of her own teaching and learning experiences were not valued.

Well this one particular teacher I'm thinking about, he taught a course – I think it was about the history of education – it was a general type. But he was not very hospitable at all, and just made me think, "I wish I had time to go to the library during this time and do my own research and not have to listen to him." – Stephanie

Stephanie's perspective about her own educational studies and preparation was expressed as contradictory comments and ambivalence.

And then there was another class I thought was kind of worthless, but in general I thought the courses were okay. I thought that they made you think, I learned a lot about the different philosophies of people in the past, plus philosophies of the people that were actually teaching me. And I was not at all disappointed in the education that I got from [the University]. – Stephanie

However, Stephanie and other participants positioned themselves to continue their education scholarship through professional conferences and workshops. Stephanie

focused on conferences as a primary source of her science literature knowledge and perspectives on science education.

And going to these conferences, like NABT or NSTA – hey, I would always go to one of those every year because I got so many ideas from other teachers in different parts of the U.S. – Stephanie

Intellectual Interest

Intellectual interest was characterized by the participants' academic interest in science and their desire to foster student literacy and participation for its own sake. Kelly incorporated information on the participation of diverse groups of students in science as part of her understanding of science education literature. She shared that she was perplexed by the statistics of historically underrepresented groups in the science pipeline and how this information influenced her teaching. Data coming out of the literature verified to her the power of role models within the field of science to represent the success of the field for diversity. For example, she stated,

I just think it's weird that they're not already in the pipeline, but I guess numbers and data show that they're not. I don't know what's going on. Even when I was a kid, I never thought that I couldn't be a doctor, and that was back in the '70s when I was a kid, or in the '80s. I just think in a way kids need to see women that are out there – do you know Neil deGrasse Tyson, who he is? He's black, he's an astrophysicist, he's like the Albert Einstein of the astrophysics world right now. They just need to see people of their own type doing it. They need to go to female doctors, they need to hear black astrophysicists and see Hispanic astronauts. That's probably, to me, the thing that speaks the loudest is to see something that's really like them that's doing it. But it never hurts to have teachers that are in the classroom, encouraging kids outside of our – but it's so strange 'cause some of our best students are girls, some of our best physics kids are female. – Kelly

Kelly pointed out the contradictions and ironies of science and science education. Yet a striking finding from these interviews was Elaine's extant science education literature.

She discussed science education literature as the knowledge and understanding of promoting scientific literacy of all her students.

I guess because as more people diversify in science they're realizing that we need a bigger workforce, some of it, but I think some of it is being brought over from really the liberal arts more, if you want to know the truth; that would be – I think as our society is becoming better educated about such issues, science is being influenced. I don't know if it's coming from within the scientific community I guess is what I'm saying. – Elaine

The next section will address the categories, themes, and findings relevant to Research Question 3.

Research Question 3 – What types of teaching strategies relevant to diversity do science teachers use?

In the following excerpts, the data for Research Question 3 addresses information regarding teaching strategies the participants use. Two categories, teacher-student interactions and curriculum and instruction considerations, were examined.

Teacher-student Interactions

The category teacher-student interactions exemplify strategies and practices for working with and supporting students. The theme is instructional support, which will be discussed in the following excerpts.

Instructional Support

Instructional support refers to participant understandings of interactions that teach, support, and facilitate student learning and development. Elaine and Lisa attempted to be more responsive to student needs and interests and to work with the different ways

students learn. Elaine focused on hands-on activities to engage her students in class effectively.

I think the best thing that I did – and I did it in all my classes, was that I planted peas in a cup and we watched them grow. And we did it the first day of class. So I had juniors in high school fighting over who watered these pea plants. So that was one of the biggest things I tried – most of it is hands-on stuff to get the difficult students involved. And I would say that was a really big thing. I tried to do a lab activity every single day and that was always something – like I had a student that had turned nothing in for an entire semester, I mean for the first two weeks. And then we had a microscope out and he was like, "Can I look at the microscope?" And I'm like, "Absolutely." And then he did those, but he still didn't do any of his other work. But I'm like he still got something out of being in class, which is what was important. – Elaine

Lisa strived to enhance student learning by taking students outside for science learning and to connect them with real life experiences.

I think it was getting them to do things like doing some labs and some hands-on stuff and connecting it to the real world because I think they had no idea that what we were doing was learning and that it was going to apply to them later on, and that they found – I don't know if I want to say they found that being outside was a good thing because I took them outside and these were students that weren't used to seeing the outside, so they were, "Oh, this is fun." I really think I connected it to their real life and it made them more interested or more motivated to learn it so some – yeah. – Lisa

Nancy offered instruction and support in varied ways:

I've done summarizing and note-taking, I've done compare and contrast; I mean if you read all about all the Marzano's Big Nine or the Essential Nine, all of those – any shape, form or fashion that I can have to engage students I do: labs and varying labs from "Here are the very specific standards," to "Just here is the question and the materials that you might like on this card over here – create, a lab to figure out this answer," I've done the complete spectrum because I feel like there's going to be something that's going to connect to one kid. – Nancy

Supporting student success was for Kelly an important instructional method. She stated,

Anytime you can make a kid feel like they've been a success in something where they thought that it was going to be a disaster and they are successful – truly

successful. I don't mean like you helped them to the point where they had success but where you facilitate a little and they brought themselves along a lot; that, to me is big success. – Kelly

To facilitate student success, Monica focused on encouraging classroom participation.

She had high expectations and communicated with her students that their participation in class was crucial.

So me being patient with them, it works a lot because it shows that, "Okay, I'm going to stick with you. You're not just going to think that you're going to act crazy or blow me off and I'm just going to run away. No, I'm going to be right there." – Monica

Monica relayed an example of working extensively with a student to encourage his participation in class and increase his beliefs about his own learning:

I had a student and he just would not do work. I was teaching physical science and that was math-based science; it was not your usual recall like biology and ecology – your life sciences. And he just would not do it. So what I ended up doing every quiz or every assignment I would just sit right there beside him and just wait on him to do anything: to ask me a question, to do something. And one day he did: he asked me a question and I showed him step-by-step how to do it. And then he start doing the problems, asking me for help, and he ended up just start doing work in my class because at one point he wasn't even doing work in the class. So I think just me realizing that students just need patience to success in the class, and sometimes they don't know how to ask for help when they need help. – Monica

Stephanie's interactions with students were a catalyst for her to improve the instructional support she offered to them.

But one of the things I made it a point to do when I taught biology is even if they're not the cream of the crop, they need to learn too. And I taught some of the kids that other teachers said, "Well I wouldn't teach that kind of kid for anything in the world." And I thought, "Well, kids are kids." So some of my greatest successes were the ones that everyone had written off as being dumber 'n heck, you know. – Stephanie

Stephanie added that interest in instructional support came from her desire that all students have quality instruction and preparation.

I think there are a lot of kids who have been beaten down academically because probably their teachers before me didn't know how to educate a student that had some challenges. So I was determined that everybody was on the same footing, I was just going to start out and I was just taking it for granted that they could learn. So I treated everybody the same – I didn't treat Little Johnny like he was mentally retarded. So when he sat in the back of the class in the corner I'd say, "Come up here; this is your seat on the front row." And I wouldn't let them sink into their stereotypes because I just assumed I could teach anybody. – Stephanie

Nancy and Lisa expressed the perspective that respect displayed in teacher-student interactions promoted instructional support. Nancy embraced a communication style she hoped students would find in her classroom a more supportive learning environment.

But building that trust with the student and knowing that that kid can honestly come up and say something to me like that, like, "Can we address this?" then I am able to address that so that we can be respectful of each other. So I think the honesty, trust, and respect are the three big key ideas that I would make sure that we had. – Nancy

Similarly, Lisa discussed the following strategy grounded in establishing positive relationships among teacher and students:

I think when I started a good relationship with my students at the beginning, like knowing what they like to do and the ones that were antischool, I try to kind of tap into what they would like, like whether they were more artistic, whether they were more musical, whether they were more jump around, let's learn things kind of thing because we did the phases of mitosis in my biology class where they stood up and they had to act it out. – Lisa

In addition, Nancy spoke to class size as a factor in establishing positive relationships in the classroom.

Class size is huge. We can always say, "Back in the good old days," I mean I love block scheduling; I would never go away from it. But when you have a class of 35 kids and you have them for 90 minutes a day for 180 days, it goes really quick.

So when you only have them for one semester, and 90 minutes a day for that one semester, it flies by. We used to have them for 180 days at 55 minutes and so you'd see them every day and you could kind of follow their natural cycle of what the kids were like. So I think that you can engage kids if you have built a relationship with them. And sometimes it's hard to make that relationship happen in a 90-minute, 90-day period of time. – Nancy

For Elaine, instructional support was demonstrated by a well-organized and managed classroom. Elaine found that as she established and maintained a schedule she was better able to engage students in learning activities and increase their classroom participation:

So I had really high standards and I had a very rigid schedule, which wouldn't work for every (teacher), but it worked for me. And I found that if I could engage that the first week it was really helpful for me to maintain – if I could have my classroom management maintained then I had so much more ability to teach. So I would think that that was probably the biggest issue was classroom management issues. – Elaine

Curriculum and Instruction Considerations

Curriculum and instruction considerations refer to the content and scope of the curricula and instructional practices. Relevant to this category, four themes emerged, including perceived characteristics of students; family and community support; daily life and future goals; and national, state, and local standards.

Perceived Characteristics of Students

Perceived characteristics are the participants' perceptions of the characteristics of their students and antecedent correlates of their perceptions. For example, Elaine's perceptions of her students were:

High absenteeism, lack of parental involvement, safety at home, safety getting to school; those are a lot of the things. – Elaine

Lisa observed that some students held lowered self-efficacy of their participation in school and less positive attitudes about their academic success.

I would say their attitude towards just school in general. I think when they come in with a bad or negative attitude it – and I don't know where they get that, whether it's parental or peer group or where, but they have this wall and they just think, "Okay, I'm not going to be able to learn this so I'm not even going to try." So I think that the greatest challenge is getting them – I don't know if it's a self-esteem issue, too; it could be. They come in, they've had failures in other classes; they failed a lot. So they come in with this negative attitude, "Why am I even going to try this because I'm going to fail?" So that's the negative attitude that I've seen. – Lisa

Further, Lisa thought that high student absenteeism may be related to social and behavioral issues.

From my experience sometimes it would be like suspension – out of school suspensions, some occasions, because they would get into trouble. Other times – I know I had one student that she just was sick all the time. And I'd try to call her parents but I couldn't get anybody there. So she would just say, "Well I was sick that day." I'll bet she missed almost 30 days the first semester. – Lisa

Elaine's idea to address high absenteeism was to develop lessons and activities that encouraged and maintained student participation in class.

-just a lot of it was maintaining the classroom, but the idea is to get the students engaged. Like the more that they feel engaged the more that they'll come to school and things like that. And then getting the community engaged; they had community forums where people could come and talk and we went out into the community – Elaine

Kelly revealed that the socioeconomic status provided insight into student diversity:

There's no nice variation – it would be much easier to work with if it was nice variation but it's pretty much extremes. Working with kids that are coming from a low socioeconomic background, they're just bringing more into school, more issues, less parental involvement. – Kelly

Kelly's observation about socioeconomic status as a consideration may be related to family and community support, which is another theme of curriculum and instruction.

Family and Community Support

Family and community support refers to the involvement of families and community members in the child's education, and familial and community experiences and concerns affecting students' school engagement and participation. Lisa discussed the participation of parents and caregivers and positive peer influence as a factor of positive academic outcomes in students.

One thing I'm big on is parental involvement. I do think a lot of times I don't get a lot of parental involvement. It's frustrating to call a parent and their phone's been disconnected, or they don't return my phone calls. I feel like sometimes those students don't feel like anybody cares about them. So lack of parental involvement would be the main thing because they don't have anyone to look up to. It's like they have no role model, and they're kind of lost. So I would think that's my biggest challenge is getting parents involved because I think that if they saw parents – and peer groups too are important; peer groups that were interested in doing school or doing well in school would be a good thing. – Lisa

Kelly observed that children from single-parent families or families headed by a grandparent face distinctive school challenges that are associated with family engagement. Kelly describes:

And I'm talking in terms of generalities here because certainly we've got some kids who come from poorer homes where the parents are very involved and very much want the very best for their kids and stay on top of it, and what you see in those homes is regardless of the fact that it's – if the parents are involved with the kid, the kid has a pretty high chance of success. But I think what you see a lot are kids that are coming out of one-parent homes or being raised by grandparents and there's not a lot of parental or grandparental control or the grandparents don't know quite what to do with the white kids coming through and those kids struggle academically; and a lot of times they struggle socially too. – Kelly

Some teachers experienced challenges in their attempts to foster consistent communication with their students' families. For example, Monica talked about children who lacked a fixed, regular residence and experienced frequent mobility or lived in housing where they dealt with abuse.

For my students, the challenges that we see are students not having a permanent home to sleep in; they're moving all the time. We have the challenge where they're getting abused at home. Some of the students are not even on their correct reading level, like they're just that far behind on their reading level. – Monica

Kelly added that students' cultural background influenced their academic experiences and school progress. She noted:

With the Hispanic students it seems to vary. With Japanese students it never varied; to my knowledge I never had a Japanese student that came from a one-parent household, and the parents are very involved with those kids. I don't know how that works in Japan, if they're – I mean I know Japan's a homogenized culture, but I would imagine that the divorce rate's not quite so high and the – I don't know that people have children that are not married very often in Japan. – Kelly

Nancy offered that more guidance from teachers can help parents become more involved with their child's education and guide their children in experiences contributing to student achievement.

Some of them, parental support – and I would even try and quote but parental support was at varying levels on the continuum. And some of that was not because a parent didn't care; it was because they maybe had to work at night because that was the only work they could get. So we had to be creative in ways in which I could help connect to those parents; I couldn't do a phone call at night to say, "We need to discuss your child," because the parent would be at work. So we had to come up with new ways in which for us to connect, to be able to help the student. – Nancy

Beyond family and community support, daily life and future goals were another theme of curriculum and instruction considerations.

Daily Life and Future Goals

The theme daily life and future goals referred to the participants' perspective that curriculum and instruction must have meaning in the daily experiences of students in addition to preparing them for future goals. Engagement, or the perceived lack of it, was a challenge discussed by the participants' in their attempts to help students connect the importance of science literacy to their daily experiences and future goals. Lisa shared the following perceptions:

I could think that they weren't in the mood to be in the classroom anyway; they did not think that science was important, they didn't value education. I think that they didn't see that it could be interesting, that they needed to know these things; they just thought it was a place for them to be babysat. So it was kind of sad. Yeah they just didn't value it or think it was important. – Lisa

Kelly added that a student may enter class with a certain degree of motivation and direction.

So there's a message, I think, that kids grow up with, that we are, as a family, sending you on past high school, and so high school is basically a building block to college, not an end. It seems like so many of our lower socio and economic kids, their parents maybe did not go to college or don't have much college and they aren't told the reasons why they should go beyond high school. And it's a message I think that kids get from early on, the expectation is success in our family means college or success in our family means you grow up and you just find a job straight out of school and start earning your income then. – Kelly

Monica offered support to boost or sustain student engagement and to help students better understand the extent of future academic and professional opportunities.

That's why I pushed them because they would say "I don't want to go to college; I don't want to do this." And I know out there they always say, "Go to college; go to college." But if it's not for you, don't waste your time to go to college. Go and find something that's going to fit what you want to do. – Monica

Elaine cited that the lack of role models and mentors affected student engagement in school and science learning.

One of my biggest reasons would be because they didn't – they went through school and didn't feel like it was something that they saw people doing. So it seems like – if you didn't know anybody that was an engineer, you didn't know anybody that was a nurse, you didn't know anybody that was a doctor and you went through school, you might not think to do those things. So they weren't represented in the beginning, it just kept continuing to be. – Elaine

And in the beginning I think those groups were excluded historically. So once they were included it was – you had to have extraordinary people being willing to cross the boundaries to be reflective of being in that position. I mean I think that's true for all students, including like gender. I think that I could have ended up being an engineer but I didn't know anybody in my life that was an engineer and girls were not promoted to do something like that. So I can see that in my own life as well. – Elaine

Participants also discussed national, state, and local standards as considerations of curriculum and instruction.

National, State, and Local Standards

National, state, and local standards direct and shape curriculum and instruction. In one example, Monica described that curriculum and instruction pacing guides offered less autonomy in teaching and learning.

I do feel pressure with how much they ask us to teach within the standards. As far as me keeping a pacing guide – most of the time it's better for me to make sure they have a lot of fun interacting, you know, notes and stuff, so they won't feel as though it's an everyday thing. I never take notes the same way every day. Sometimes we do feelings, sometimes you write on pictures; I mean it's just all different. Sometimes you look at the book and fill in; sometimes you work in a group and get some notes. – Monica

Furthermore, Monica emphasized,

Students who usually do not engage – they have a weakness in the subject. They've had a weakness before time. So I know when I open my class up, I let

them know, "This is a fresh new start; it's a fresh teacher – try science out again if you've given up on it in the past." – Monica

Lisa focused her teaching and classroom time on the in-depth discussion of topics rather than focusing on the number of topics covered.

So in order to slow the curriculum down and do more activities with these students and get them more involved and more motivated and wanting to learn we – this curriculum was stretched out over two semesters. So like the first semester we would slow it down a pace, do a lot more activities, a lot more labs because these were students who needed to be – needed slower learning times; they weren't going to get it all in one semester. – Lisa

Nancy decided to continually focus on different methods of facilitating student engagement and learning.

So when they say "research best practices" and that type of thing, when I have gone to workshops, I have gone to different things – if you have read about it I have probably tried it because I will do whatever it takes to get those kids to succeed. – Nancy

Stephanie directed class discussions to the personal interests of each student in her class.

So what I tried to do was find topics that interested these students – this sounds terrible because I'm not a pervert or anything, but if they were interested in, I'd try to get them interested in learning about reproduction of all animals because I figured once I had their interest I could weave in everything else I wanted them to know, if I could just get their attention. – Stephanie

Kelly addressed the challenges of changes in national, state, and local standards and student demographics:

There's been so many state changes in the last few years that kind of caught in this crossroad between our population has changed – so the demographics have changed and then the state is changing so much of the – just the standards and the testing and the way that we're supposed to do school has changed that we are presently undergoing the biggest change of – this is my 14th or 15th year, but this is the biggest change at school that I have ever experienced. – Kelly

Stephanie recognized that curriculum and instruction did not support the full participation of all students:

I feel like that must have happened back in grade school, that they just didn't get the concepts and nobody was willing to spend the extra time with them. And to me that's the key – it's not necessarily their intelligence, it's just do you have somebody that's willing to give them the time they need to learn to do this? And a lot of people aren't, and the school system isn't; they want to get people up and out. – Stephanie

Well it really hurt my heart that I feel like some people don't get the same chance that everybody else does, and I just want an equal playing field, I want to see taxes doled out to where everybody gets the same amount of money. I don't want to go into a school of Magnolia and find out that they don't have the same things they have at Verde – that's not fair. That's just the way I look at it. I think if you think these kids can't learn you're not doing it right because they might not ever get up to the same level that they do at but they can rise. – Stephanie

Like Stephanie, Elaine observed disconnect in the support received by teachers and students such as:

But I mean for me personally one of my biggest criticisms of the school system is that there's such a discourse between the schools in terms of segregation that it's like people that are teaching in these upper middle class schools are so distant from what's going on, there's just this – I would think the schools would benefit from everybody doing some type of things so there would be less – sometimes I feel like decisions that were made were not reflective of what was going on at our school and what our schooled needed. – Elaine

The teachers alike discussed factors influencing student engagement. For example, an observation by Elaine is that engaged students are more likely to perform well academically. I think the hardest thing was we have a pretty rigid curriculum, especially for biology. And the hardest thing was just – most of my students that were hard to engage in science were just hard to engage in school. So I wouldn't say that it was necessarily science class; we had a lot of students that really had very few credits, and yet they were being forced to come to school. – Elaine

Nancy asserted that curriculum and instruction must recognize the challenges that some students experience. She described the following:

I would say first thing is foundation; they did not necessarily have the initial foundation coming in, in terms of importance of education. Not always, and these are very generalized statements, but typically. Had a lot of students that might not have had the resources. When you had some of your upper socioeconomic students, they could get online and research things on the internet, and some of my lower socioeconomic students didn't have that as a resource that they could use at home. I mean they could go to the library and that type of thing but it wasn't as accessible. – Nancy

Nancy observed that it is essential that teachers foster science learning and positively shape student attitudes.

And as they progress through the education system, I think we lose some of that natural curiosity by turning to a textbook to be the teacher and not allowing students to be engaged in their own learning; instead they're reading a book. So foundationally they come in without the passion for science. And that's not just one group; that can be a lot of students. – Nancy

Chapter Four provided the research findings and demonstrated the layers of categories and themes. In Chapter Five, an analysis of the data is presented along with a discussion of the implications for teacher preparation, policy, and practice.

Chapter 5: Conclusions, Discussion, and Suggestions for Future Research

Introduction

The current study was conducted in part to learn and glean insights from six science teachers based on their experiences of working in schools and classrooms with a diverse population that is often marginalized in the society. More specifically, it was an attempt to garner their perspectives about conceptions they have of diversity, knowledge they have acquired about teaching diverse learners and the sources that inform their understanding, and the types of teaching strategies they use for reaching and engaging diverse students in the process of learning science. The expectation was to gain insights from their experiences to deepen the understanding needed for more effective teaching and learning in a context of shifting demographics and to contribute to the emerging body of literature on teaching science to diverse learners. Further, it was an attempt to learn from teachers active in the field and to be more deliberate about considerations for improving teacher preparation and staff development. New challenges, and often forgotten opportunities, appear to be central in the current discourse of science education.

This chapter is an effort to share a summary of what has been learned from the voices of study participants, new issues and questions their voices generate, and implications salient to the field of science education and the preparation of new science teachers. Therefore, this chapter begins by discussing the participants' stories as related to addressing the research questions. The four assertions stated in the conclusion of Chapter 2 are discussed and integrated in the discussion of the research findings to abridge the key ideas from the literature review to the current study's conceptual

framework, and the participants' stories. The first assertion is that there are different ways of conceiving and organizing teacher preparation, reflecting views of teaching and learning to teach and different orientations to the preparation of teachers for diverse learners. Second, there are tensions in science education regarding scientific epistemological views, reflecting key differences in core values and worldviews, and essential components for guiding instructional practices for diverse learners. The third assertion is that there are disconnects between theory and practice of approaches to prepare teachers for work in urban contexts and to meet the needs of diverse learners. The fourth assertion is that there are gaps organizationally and conceptually between science education and culturally responsive pedagogy.

Addressing the Research Questions

The participants' professional and personal stories are central to the perceptions of their work, and provide insight into the three research questions. Key to their stories is the following understandings: Their stories involve a desire to teach; that is supportive and attempts to make a difference, including social justice; and that teaching is a value relationship with students. They tell stories that teaching is dynamic as they respond to pedagogical considerations of the knowledge and skills essential to encourage student interests in science and meet student needs. The participants tell stories that teaching is a reflective practice; therefore, their teaching is a process of learning, rethinking and reviewing curriculum and instruction to encourage student engagement, participation, and efficacy.

In Chapter 2, four traditions (academic, social efficiency, developmentalist, and social reconstructionist) of teacher preparation were discussed (Zeichner, 1993). Each tradition represents different ways of conceiving and organizing teacher preparation and reflects views of teaching and learning to teach. The participants expressed beliefs that learning to teach is a lifelong process and practice to find creative ways to help students grasp concepts and complex ideas. It follows that for the participants' teaching is a matter of creating a supportive classroom environment conducive to student learning in which their students have the opportunity to grow. With this knowledge the participants described selecting materials and activities to respond to sociocultural factors including institutional context and learning environment that influence teaching and student learning. The participants emphasized making a difference such that teaching and learning is derived from students' personal context – all those attitudes and aims that expressed the individual student's relationship with self and as learners of science.

The findings of this current study demonstrate that the participants' knowledge of teaching and learning to teach is a complex culture and history that encompassed different forms of learning. Participants shared that networking with other teachers and development-while-teaching and inservice were strategies they utilized as professional development opportunities. Specific examples of the participants' extracurricular scholarship were participation in Project Success, completing the application process for national board certification, and attendance at professional meetings and conventions. Also, teaching-related knowledge includes professional insights developed from their interactions, challenges and opportunities, with their students. Further, experiences in

high school and college science and science education classes were firmly rooted in their early teacher development and strong factors underscoring their teaching and learning.

The participants' learning is active rather than passive and each participant constructs understandings in response to environmental influences, which emphasizes perspectives of philosophical and sociological constructivism. In recognition of the bioecological model, the participants' teaching and learning develop and are shaped through multiple contexts including cultural, historical, and institutional. Teaching and learning is influenced by characteristics of the context such as teacher preparation, and school demographics. Further, individuals, for example, students, teaching colleagues, and mentors impact the participants' teaching and learning. Consciously or unconsciously, they construct their own meaning from these interactions and experiences, which shape their worldview and contribute to and guide their values and beliefs about teaching.

When the participants discuss their learning experiences, they discuss a range of contexts including networking with other teachers (teaching colleagues and graduate school peers and mentors), Project Success, application for national board certification, and professional meetings and conventions. The participants' learning experiences involve a complexity of processes. They involve both observation and practice through classroom experiences. Through their observations and experiences, these educators described learning as they monitor and adjust curriculum and instruction for national and local regulations and outcomes. Since the participants had acknowledged that developing

relationships with their students is a big part of teaching, they discussed that their learning experiences involved interacting with students.

A second assertion is that there are tensions in science education regarding scientific epistemological views, reflecting key differences in core values and worldview, and essential components for guiding instructional practices for diverse learners. Underpinning and embedded fundamentally in the participants' core values and worldview is their multicultural discourse. A key aspect of the participants' multicultural discourse is that teaching and learning should be relevant to the lives of students and should reflect their ways of learning as well as their sociocultural backgrounds. Specifically, in their discourse the following themes emerged: social justice, reflective practice, and valuing students. Social justice conceptualizes teaching and learning for full participation of all students and applies teaching in the classroom to activism. Core values and worldview are implemented in reflective practice, as participants are thinking about what they do and how and why they do it. In Chapter 4, a finding reflecting the core values and worldview of the participants was valuing students. Valuing students grounded the participants' discourse on multiculturalism and is related to their conceptualizations of diversity.

For the teacher participants' core values and worldview to be understood in-depth, we must examine the participants' conceptions of diversity, which are reflected within the themes: individual differences, categorical attributes, and pedagogical considerations. Participants recognized diversity as including differences on any number of characteristics, for example, culture, ethnicity, interests, languages, and learning styles.

Related diversity encompassed a myriad of attributes to describe groups of students, such as race, religion, age, and background. Further, the participants' conceptions of their students revealed the perspectives that teaching strategies are relative to student differences, in particular the ways in which the nature of the curriculum and instruction contribute to students' meaning-making and learning. Lastly, the participants' conceptions of diversity reflect learning and knowing, which occurs in a variety of social relationships and contexts and nested levels of influences.

The participants enjoyed science, so their intellectual interest was a valuable resource for them to work with classes or students that did not participate in class, were less enthusiastic about the subject, or struggle with science. Learning experiences began even before they began preparing to become teachers. High school and college classes and coursework gave them the opportunity to observe and experience models of teaching science. These experiences made them ask whether science would be a career that they would choose, and for science teaching how they might want to teach their future students. Teacher preparation gave the participants an opportunity to work with students who have a range of academic backgrounds, science knowledge and out of school experiences. Further as new teachers the participants did not learn and work in isolation, and expressed that they felt nurtured in their teacher preparation environment.

The participants reported how they organized content, set activities, and developed a classroom environment with ideas for how to give quality instruction and preparation to all their students. Participants indicated that they made choices about what students do in order to support academic progress, encourage participation, and explore

beliefs about their own learning. These educators discussed teaching strategies based on their explorations of what they knew about how their students learn, and their attempts to be responsive to students' real life experiences. Before adopting particular teaching strategies, participants reported that they attempted to develop positive teacher-student interactions. They recognized that positive student interactions were another important aspect of learning useful to include in curriculum and instruction design.

A third assertion is that there are disconnects between theory and practice, including approaches to prepare teachers for work in urban contexts and meeting the needs of diverse learners. This is an important assertion gathered from the review of literature. The participants in this current study discussed that a primary influence and context of their teacher development and learning occurred through observation and practice in the school context in which they taught. In his seminal work, Bronfenbrenner (1979) presented the notion that "context matters" in development and learning. Perceptions, thoughts, and beliefs, as Bronfenbrenner would argue, evolve as a function of a person's exposure to and interaction with the environment (Bronfenbrenner, 2005). Interactions between the participants and their school contexts and complexities of relationships and interactions with students dynamically contribute to the outcomes of the participants' development and learning. Further, the participants' observation and practice in the school context represented an ongoing process of learning that crossed all aspects of their teaching and learning. Specifically, participants discussed classroom experiences as the theory from which their knowledge of teaching diverse learners emerged and represented sources that guide their understanding.

Student engagement, how teachers engage with students and get them to participate in activities, was a critical theme of their theory and practice. Engagement, or the perceived lack of it, was a challenge discussed by the participants in their attempts to help students connect the importance of science literacy to their daily experiences and future goals. Therefore, the participants shared the perspective that curriculum and instruction must have meaning in the daily experiences of students in addition to preparing them for future goals. Participants reported thoughtfully directing instructional support to students, using interactions that teach, support, and facilitate student learning and development.

Participants attempted to be more responsive to student needs and interests and to work with the different ways students learn, and focused on hands-on activities to engage their students in class effectively. To facilitate student success, participants encouraged classroom participation and communicated high expectations to their students that made sure students understood that participation in class was crucial to their academic success. Additionally, participants expressed the perspective that respect displayed in teacher-student interactions promoted instructional support. Communication styles and well-organized and managed classrooms were developed to create a more supportive and engaging learning environment for students.

Participants expressed that their teacher preparation and professional development did not consistently address the social and pedagogical relevance of their teaching science to diverse learners. For the participants, their classroom experiences provided more guidance and the tools needed to teach diverse learners. As a result, they worked to

develop interactions with their students that were personalized and responsive to individual needs. The daily interactions with their students shaped and were a primary source of professional knowledge development. Accordingly, the interviews drew attention to the observation that their teaching experiences helped the participants to make sense of student demographics and classroom and school dynamics. The participants expressed that teaching was not a linear, one-way sharing of knowledge. The interactions with their students required that they adapt to evolving student needs, interests, and feedback.

In this study, it is offered that the participants are intuitive social constructivists (McRobbie & Tobin, 1997). The participants recognize the complex set of interactions and social constructions shaping their and their students' perspectives and how these influences impact science teaching and learning. The participants found themselves addressing teaching across student diversity based on their own understanding and through dialogue with peers. The findings indicate that the participants' teaching experiences gave them opportunities to extend their own active learning, and to integrate and align best practices in their classrooms. Therefore, the participants discussed and explained their teaching as related to a number of considerations such as perceived student characteristics, family and community support, students' daily life and future goals.

In addition, national, state, and local standards direct and shape curriculum and instruction. Participants described that curriculum and instruction pacing guides offered less autonomy in teaching and learning. Yet, teachers participating in the current study

shared examples of creative ways they engaged their students in science. A primary practice was hands-on activities. These participants offered illustrative descriptions such as hands-on, inquiry-based, interactive projects, and explorations as characteristics of their approaches to instruction.

A fourth assertion is that there are gaps organizationally and conceptually between science education and culturally responsive pedagogy. The participants articulated and described in-depth qualitatively different forms of learning and ways they approach their own learning. For example, the participants learn about science education via practitioner scholarship or through their own praxis. Participants espoused that these interactions and the understandings they gained from them supported them in more effectively meeting individual student needs and interests resulting in improved science achievement for their students. Participants explored different teaching strategies in which students are active and in which the focus is more on student participation and learning. With teaching strategies, participants told of using modified curriculum and instruction to meet class size, perceived student characteristics, family and community support, daily life and future goals, and national, state, and local standards.

It is arguable that the participants conducted reform-minded science teaching, which assumes knowledge, skills and strategies for effective science instruction and a body of knowledge and a body of beliefs and values that align with current reform (Cochran-Smith, 1991). As the teachers transitioned from preservice to inservice, it was not clear if the participants' theory and practice, their knowledge about teaching and learning fully reflected the range in theories and practices of culturally responsive

pedagogy, as described by leading scholars. Inconsistent participation in professional associations, a lack of key routes for continuing education, and curriculum and instruction guides were discussed as reasons for the gap between the participants' science teaching and culturally responsive pedagogy. The participants may have recalled little specific guidance from literature facilitating their professional development.

Interestingly, in this case, some of the participants position themselves to continue their education scholarship through professional conferences and workshops. Their extracurricular scholarship may demonstrate emancipatory knowledge or a self-awareness or critical reflection and self-reflection of themselves (Cranton, 2002) as an important part of the participants' learning process and knowledge construction.

Similarities were apparent in the participants' academic interest in science and their desire to foster student literacy and participation for its own sake. Their intellectual interest is an essential part of their understanding of science education literature, and often facilitated by role models/mentors and former teachers in shaping the participants' own teaching and learning and success in science education.

Study Limitations

Further research may address the limitations of this study. One limitation is that the study population was not a diverse group. Having a greater diversity among the participants could have added to understanding the data in other ways. The study population does reflect a similar distribution of teachers in the field of education on the national level, especially for science education. Additionally, the current study did not explore the effects on the learning process of diverse learners if they have a teacher with

similar characteristics (i.e., race, culture, language) as themselves. This study is also limited in that it only explored the concepts of diversity, standard of knowledge, and teacher strategies of six teachers from the southeast region of the U.S. Exploration in other regions has the potential of contributing different insights. A final limitation is that the study population consists of only females and did not include the perspectives that could be gained from male teachers.

Study Implications

Teachers' conceptions of diversity, the standards of knowledge, and teaching strategies for diverse learners have the potential to play an important role in the teaching and learning process. They often contribute to shaping classroom practices and guiding teaching decisions. Understanding the knowledge-base of teachers and their beliefs and teaching practices is important for engaging and teaching science to diverse learners. This study was designed to examine and share insights from a small group of science teachers. It reveals the value of teacher-generated knowledge and understanding for reforming teacher preparation and staff development. Strategies teachers use for teaching diverse learners and the meanings they attach to them are important to examine.

Although the idea of contextualizing science instruction to facilitate student understanding of scientific concepts has been discussed in the literature (Rivet & Krajcik, 2008), the findings of this study advance the idea of contextualizing teachers' experiences as well. The expectation is that professional development contextualizing teacher experiences (for example, demographics of field placement, teaching internship, or inservice practice) will catalyze self-awareness and inquisitiveness of their learning

process. Linked to contextualizing teacher experiences is the idea of enhancing teachers' knowledge construction and culturally responsive pedagogy.

Future Research

Beyond this study, the considerations that must be given to inquiry of teaching science to diverse learners should involve an examination of theoretical perspectives and practical experiences that support exemplary teaching and mentoring of diverse learners. Future research should include a more diverse group of teachers. For example, future research should include the voices and perspectives of male teachers and under-represented women, with the inclusion of linguistic, racial, and cultural diversity in the science fields. Finally, an examination of the influences on the learning process of students matched with teachers of similar backgrounds should be explored. It is the norm for majority-society children. However, little understanding exists about the role this plays, or should play, in teaching diverse students, particularly in content areas such as biology, chemistry, and physics. The complexities of diversity challenge not only teachers but also our society and world as a whole. Although it is impossible to match students and teachers of similar backgrounds and experiences and perhaps not advisable, it is important to capture what we know and can learn about differences and how this understanding can contribute to more effective ways of teaching. Future studies can inform us of what matched experiences can add to the learning process and what is missing in its absence.

References

- Achinstein, B. & Ogawa, R. T. (2012). New teachers of color and culturally responsive teaching in an era of educational accountability: Caught in a double bind. *Journal of Education Change*, 13, 1-39.
- Allen, J. & Hermann-Wilmarth, J. (2004). Cultural construction zones. *Journal of Teacher Education*, 55, 214-226.
- Allen, J. B. & Labbo, L. D. (2001). Giving it a second thought: Making culturally engaged teaching culturally engaging. *Language Arts*, 79, 40-52.
- American Association for the Advancement of Science. (1990). *Science for all Americans*. Introduction. New York: Oxford University Press, Inc.
- Retrieved from <http://www.project2061.org/publications/sfaa/online/intro.htm>
- Anfara, V. A., Jr., & Mertz, N. T. (Eds). (2006). *Theoretical frameworks in qualitative research*. Thousand Oaks, CA: Sage Publications, Inc.
- Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching*, 47, 564-582.
- Atwater, M. M. (1996). Social constructivism: Infusion into the multicultural science education research agenda. *Journal of Research in Science Teaching*, 33, 821-837.
- Atwater, M. (1998). Science literacy through the lens of critical feminist interpretive frameworks. *Journal of Research in Science Teaching*, 35, 375-377.
- Aud, S., Fox, M., & KewalRamani, A. (2010). *Status and Trends in the Education of*

- Racial and Ethnic Groups* (NCES 2010-015). U.S. Department of Education, National Center for Education Statistics. Washington, DD: U.S. Government Printing Office.
- Aud, S., Hussar, W., Kena, G., Bianco, K., Frohlich, L., Kemp, J., Tahan, K. (2011). *The Condition of Education 2011* (NCES 2011-033). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office.
- Banks, C. A., & Banks, J. A. (1995). Equity pedagogy: An essential component of multicultural education. *Theory into Practice*, 34, 152-158.
- Banks, J. A., & Banks, C. A. M. (Eds.). (2004). *Handbook of research on multicultural education*. San Francisco, CA: Jossey-Bass.
- Barton, A. C. (1999). Crafting a multicultural science teacher education: A case study. *Journal of Teacher Education*, 50, 303-314.
- Bianchini, J. A., & Solomon, E. M. (2003). Constructing views of science tied to issues of equity and diversity: A study of beginning science teachers. *Journal of Research in Science Teaching*, 40, 53-76.
- Bianchini, J. A., & Brenner, M. E. (2010). The role of induction in learning to teach toward equity: A study of beginning science and mathematics teachers. *Science Education*, 94, 164-195.
- Berkowitz, S. (1997). Analyzing qualitative data. In J. Frechtling & L. Sharp (Eds.),

- User-friendly handbook for mixed method evaluations*. Arlington, VA: Division of Research, Evaluation and Communication, National Science Foundation.
- Retrieved June 28, 2012, from <http://www.nsf.gov/pubs/1997/nsf97153/start.htm>
- Boutte, G., Kelly-Jackson, C., & Johnson, G. L. (2010). Culturally relevant teaching in science classrooms: Addressing academic achievement, cultural competence, and critical consciousness. *International Journal of Multicultural Education*, 12, 1-20.
- Bronfenbrenner, U. (1979). *The ecology of human development*. Cambridge, MA: Harvard University Press.
- Bronfenbrenner, U. (2005). *Making human beings human: Bioecological perspectives on human development*. Thousand Oaks, CA: Sage Publications, Inc.
- Bronfenbrenner, U. & Ceci, S. (1994). Nature-nurture reconceptualized in developmental perspective: A bioecological model. *Psychological Review*, 101, 568-586.
- Bryan, L. A. & Atwater, M. M. (2002). Teacher beliefs and cultural models: A challenge for science teacher preparation programs. *Science Education*, 86, 821-839.
- Buxton, C. (2010). Social problem solving through science: An approach to critical, place-based science teaching and learning. *Equity and Excellence in Education*, 43, 120-135.
- Cobern, W. W., & Loving, C. C. (2001). Defining "science" in a multicultural world: Implications for science education. *Science education*, 85, 50-67.
- Cochran-Smith, M. (1991). Learning to teach against the grain. *Harvard Educational Review*, 61, 279-310.
- Cochran-Smith, M. (1995). Color blindness and basket making are not the answers:

- Confronting the dilemmas of race, culture, and language diversity in teacher education. *American Educational Research Journal*, 32, 493-522.
- Cochran-Smith, M. (2004). *Walking the road: Race, diversity, and social justice in teacher education*. New York: Teachers College Press.
- Cranton, P. (2002). Teaching for transformation. *New Directions for Adult and Continuing Education*, 93, 63-71
- Creswell, J. W. (2007). Designing a qualitative study. In J. W. Creswell, *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed., p. 35-52). Thousand Oaks, CA: Sage Publications, Inc.
- Darling-Hammond, L., French, J., & Garcia-Lopez, S. P. (2002). *Learning to teach for social justice*. New York: Teachers College Press.
- Darling-Hammond, L. & Bransford, J. (2005). *Preparing Teachers for a changing world: What teachers should learn and be able to do*. San Francisco, CA: Jossey-Bass.
- Davis, J. & Martin, D. (2008). Racism, assessment, and instructional practices: Implications for mathematics teachers of African American students. *Journal of Urban Mathematics Education*, 1, 10-34.
- Denzin, N. K., & Lincoln, Y. S. (2005). Introduction. The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (3rd ed., p. 1-32). Thousand Oaks, CA: Sage Publications, Inc.
- Denning, M. (1992). The academic left and the rise of cultural studies. *Radical History Review*, 54, 21-48.

- DeYoung, A. J. (1987). The status of American rural education research: An integrated review and commentary. *Review of Educational Research*, 57, 123-148.
- Elmesky, R. & Tobin, K. (2005). Expanding our understandings of urban science education by expanding the roles of students as researchers. *Journal of Research in Science Teaching*, 42, 807-828.
- Ferguson, R. (2008). If multicultural science education standards? Existed, what would they look like? *Journal of Science Teacher Education*, 19, 547-564.
- Fraser-Abder, P., Atwater, M. and Lee, O. (2006). Research in urban science education: An essential journey. *Journal of Research in Science Teaching*, 43, 599-606.
- Freire, P. (2005). *Education for critical consciousness* (1st ed). New York: Continuum International Publishing Group.
- Gallego, M. A. (2001). Is experience the best teacher? The potential of coupling classroom and community-based field experiences. *Journal of Teacher Education*, 52, 312-325.
- Gardiner, H. W. & Kosmitzki, C. (2008). *Lives across cultures: Cross-cultural human development* (3rd ed.) Boston, MA: Pearson Education.
- Gay, G. (1997). Multicultural infusion in teacher education: Foundations and applications. *Peabody Journal of Education*, 72, 150-177.
- Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education*, 53, 106-116.
- Giroux, H. A. (2001). *Theory and resistance in education: Towards a pedagogy for the opposition*. Westport, CT: Greenwood Publishing Group, Inc.

- Giroux, H. A. & McLaren, P. (1994). *Between borders: pedagogy and the politics of cultural studies*. New York: Routledge.
- Gredler, M. E. (1997). *Learning and instruction: Theory into practice* (3rd ed). Upper Saddle River, NJ: Prentice-Hall.
- Gubrium, J. F., & Holstein, J. A. (1997). *The new language of qualitative method*. New York: Oxford University Press.
- Guyton, E. M., & Wesche, M. V. (2005). The multicultural efficacy scale: Development, item selection, and reliability. *Multicultural Perspectives*, 7, 21-29.
- Haberman, M. (1995). The dimensions of excellence in programs preparing teachers for urban poverty schools. *Peabody Journal of Education*, 70, 24-43.
- Hatch, J. A. (2002). *Doing qualitative research in education settings*. Albany, New York: State University of New York Press.
- Haystead, M. W., & Marzano, R. J. (2010). *Meta-analytic synthesis of studies conducted at Marzano Research Laboratory on instructional strategies*. Englewood, CO: Marzano Research Laboratory.
- Heath, S. B. (1983). *Ways with words: Language, life, and work in communities and classrooms*. New York: Cambridge University Press.
- Hodson, D. (1993). In search of a rationale for multicultural science education. *Science Education*, 77, 685-711.
- Hollins, E. R. & Guzman, M. T. (2005). Research on preparing teachers for diverse

- populations. In M. Cochran-Smith & K. M. Zeichner (Eds.), *Studying teacher education: The report to the AERA panel on research and teacher education* (pp. 477-548). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Irvine, J. J. (1990). *Black students and school failure: Policies, practices, and prescriptions*. New York: Greenwood.
- Irvine, J. J. (2003). *Educating teachers for diversity: Seeing with a cultural eye*. New York: Teachers College Press.
- Johnson, C. C. (2011). The road to culturally relevant science: Exploring how teachers navigate change in pedagogy. *Journal of Research in Science Teaching*, 48, 170-198.
- Kelly-Jackson, C. P., & Jackson, T. O. (2011). Meeting their fullest potential: The beliefs and teaching of a culturally relevant science teacher. *Creative Education*, 2, 408-413.
- Kerber, C., & Cranton, P. A. (2000). Exploring the scholarship of teaching. *The Journal of Higher Education*, 71, 476-195.
- Kim, B. (2001). Social constructivism. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Retrieved from <http://www.coe.uga.edu/epltt/SocialConstructivism.htm>
- King, J. E. (1997). "Thank you for opening our minds": On praxis, transmutation, and Black studies in teacher development. In J. E. King, E. R. Hollins, & W. C. Hayman (Eds.), *Preparing teachers for cultural diversity* (p. 156-169). New York: Teachers College Press.

- Kvale, S. (2009). *Interviews: Learning the craft of qualitative interviewing*. Thousand Oaks, CA: Sage Publications, Inc.
- Ladson-Billings, G. J. (1999). Preparing teachers for diverse student populations: A critical race theory perspective. In A. Iian-Nejad & D. Pearson (Eds.), *Review of Research in Education*, 24, 211-247. Washington, DC: American Educational Research Association.
- Lee, O. (1999). Equity implications based on the conceptions of science achievement in major reform documents. *Review of Educational Research*, 69, 83-115.
- Lee, O. & Buxton, C. A. (2010). *Diversity and equity in science education: Theory, research, and practice*. New York: Teachers College Press.
- Lee, O., & Luykx, A. (2006). *Science education and student diversity: Synthesis and research agenda*. New York: Cambridge University Press.
- Lewthwaite, B. (2011). *University of Manitoba Centre for Research in Youth, Science Teaching and Learning: Applications and utility of Urie Bronfenbrenner's bioecological theory*. Retrieved from <http://www.mern.ca/monographs/Bio-Ecological.pdf>
- Lincoln, Y. S. (1995). Emerging criteria for quality in qualitative and interpretive research. *Qualitative Inquiry*, 1, 275-289.
- Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications, Inc.
- Loxley, A., O'Leary, B., and Minton, S. J. (2011). Space makers or space cadets?

- Exploring children's perceptions of space and place in the context of a Dublin primary school. *Educational and Child Psychology*, 28, 46-63.
- Marzano, R. (2010). Representing knowledge nonlinguistically. *Educational Leadership*, 67, 84-86.
- Matthews, M. R. (1998). *Constructivism in science education: A philosophical examination*. Kluwer Academic Publishers: Netherlands.
- Maxwell, J. A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.
- McAllister, G. & Irvine, J. J. (2002). The role of empathy in teaching culturally diverse students: A qualitative study of teachers' beliefs. *Journal of Teacher Education*, 53, 433-443.
- McFalls, E. L., & Cobb-Roberts, D. (2001). Reducing resistance to diversity through cognitive dissonance instruction: implications for teacher education. *Journal of Teacher Education*, 52, 164-172.
- McRobbie, C., & Tobin, K. (1997). A social constructivist perspective on learning environments. *International Journal of Science Education*, 19, 193-208.
- Mensah, F. M. (2009). Confronting assumptions, biases, and stereotypes in preservice teachers' conceptualizations of science teaching through the use of book club. *Journal of Research in Science Teaching*, 46, 1041-1066.
- Mensah, F. M. (2011). The DESTIN: Preservice Teachers' drawings of the ideal elementary science teacher. *School Science and Mathematics*, 111, 379-388.
- Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San

- Francisco, CA: Jossey-Bass Publishers.
- Murane, R. J. & Phillips, B. R. (1981). What do effective teachers of inner-city children have in common? *Social Science Research*, 10, 83-100.
- Murrell, P. C., Jr. (2000). Community teachers: A conceptual framework for preparing exemplary urban teachers. *The Journal of Negro Education*, 69, 338-348.
- National Center for Education Statistics (2011). The Nation's Report Card: Science 2009 (NCES 2011-451). Institute of Education Sciences, U.S. Department of Education, Washington, D.C.
- National Center for Education Statistics. (2012). Education indicators: An international perspective. [Glossary]. Retrieved from: <http://nces.ed.gov/pubs/eiip/eiipgls.asp>
- National Science Board. (2010, May 5). Preparing the next generation of stem innovators: Identifying and developing our nation' human capital. Retrieved from <http://www.nsf.gov/nsb/publications/2010/nsb1033.pdf>
- National Science Foundation. (2010, January). *Chapter 1 Elementary and secondary mathematics and science education*. Retrieved from <http://www.nsf.gov/statistics/seind10/c1/c1s1.htm>
- National Science Teachers Association. (2000). NSTA Position Statement: Multicultural Science Education. Retrieved from <http://www.nsta.org/about/positions/multicultural.aspx>
- Nieto, S. (2009). *Language, culture, and teaching: Critical perspectives* (2nd ed). New York: Routledge.
- Oakes, J. (1990). *Multiplying inequalities: The effects of race, social class, and*

- tracking on opportunities to learn mathematics and science* (ED 329 615). Santa Monica, CA: RAND Corporation.
- Ogawa, M. (1995). Science education in a multiscience perspective. *Science Education*, 79, 583-593.
- Parsons, E. C. (2000). Culturalizing science instruction: What is it, what does it look like and why do we need it? *Journal of Science Teacher Education*, 11, 207-219.
- Parsons, E. C. (2008). Learning contexts, Black cultural ethos, and the science achievement of African American students in an urban middle school. *Journal of Research in Science Teaching*, 45, 665-683.
- Parsons, E. C., Foster, S., Gomillion, C. T., & Simpson, J. S. (2007). Diversity knowledge in science teacher education-translating concept to instruction: An example specific to African Americans. *Journal of Science Teacher Education*, 19, 69-83.
- Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.
- Potter, J. (1998). "Qualitative and discourse analysis", in Bellack, A. S., Hersen, M., (Eds), *Comprehensive Clinical Psychology: Volume 3*, Oxford: Pergamon.
- President's Council of Advisors on Science and Technology (2010). *Prepare and inspire: K-12 education in science, technology, engineering and math (STEM) for America's future*. Washington, DC: Executive Office of the President.
- Rivet, A. E., & Krajcik, J. S. (2008). Contextualizing instruction: Leveraging students'

- prior knowledge and experiences to foster understanding of middle school science. *Journal of Research in Science Teaching*, 45, 79-100.
- Rodriguez, A. J. (1997). The dangerous discourse of invisibility: A critique of the National Research Council's national science education standards. *Journal of Research in Science Teaching*, 34, 19-37.
- Rodriguez, A. J. (1998). Strategies for counterresistance: Toward sociotransformative constructivism and learning to teach science for diversity and for understanding. *Journal of Research in Science Teaching*, 35, 589-622.
- Rodriguez, A. J., & Kitchen, R. S. (2005). *Preparing mathematics and science teachers for diverse classrooms: Promising strategies for transformative pedagogy*. Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.
- Roth, W-M., Tobin, K., & Zimmermann, A. (2002). Coteaching/Cogenerative dialoguing: Learning environments research as classroom praxis. *Learning Environments Research*, 5, 1-28.
- Scantlebury, K., Gallo-Fox, J. & Wassell, B. (2008). Coteaching as a model for preservice secondary science teacher preparation. *Teaching & Teacher Education*, 24, 967-981.
- Settlage, J. & Southerland, S. A. (2007). *Teaching science to every child: using culture as a starting point*. New York: Routledge Press.
- Silva, D. L., Sabino, L. D., Adina, E. M., Lanuza, D. M. & Baluyot, O. C. (2011). *Proceedings of the World Congress on Engineering and Computer Science 2011*, Vol I WCESCS 2011, San Francisco, California.

- Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, 75, 417-453.
- Sleeter, C. E. (2001a). Preparing teachers for culturally diverse schools: Research and the overwhelming presence of whiteness. *Journal of Teacher Education*, 52, 94-106.
- Sleeter, C. E. (2001b). Epistemological diversity in research on pre-service teacher preparation for historically underserved children. In W. Secada (Ed.), *Review of research in education* (Vol 25, p. 209-250). Washington, DC: American Educational Research Association.
- Sleeter, C. E., & Owuor, J. (2011). Research on the impact of teacher preparation to teach diverse students: The research we have and the research we need. *Action in Teacher Education*, 33, 524-537.
- Sobel, D., Gutierrez, C., Zion, S., & Blanchett, W. (2011). Deepening culturally responsive understandings within a teacher preparation program: It's a process. *Teacher Development*, 15, 435-452.
- Southerland, S. A. & Gess-Newsome, J. (1999). Preservice teachers' views of inclusive science teaching is shaped by images of teaching, learning, and knowledge. *Science Education*, 83, 131-150.
- Stake, R. E. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (3rd ed., p. 443-466). Thousand Oaks, CA: Sage Publications, Inc.
- Stanley, W. B., & Brickhouse, N. W. (1994). Multiculturalism, universalism, and science

- education. *Science Education*, 78, 387-398.
- Stanley, W. B., & Brickhouse, N. W. (2001). Teaching sciences: The multicultural question revisited. *Science Education*, 85, 35-49.
- Strauss, A. L., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed). Thousand Oaks, CA: Sage Publications, Inc.
- Suters, L. A. (2004). An exploratory study of the impact of an inquiry-based professional development course on the beliefs and instructional practices of urban inservice teachers. (Doctoral dissertation). Retrieved from Dissertation Abstracts International. (AAI3126896)
- Talbert-Johnson, C. (2006). Preparing highly qualified teacher candidates for urban schools. *Education and Urban Society*, 39, 147-160.
- Tobin, K. & Roth, W-M. (2005). Implementing coteaching and cogenerative dialoguing in urban science education. *School Science and Mathematics*, 105, 313-322.
- Tsai, C. C. (2006). Teachers' scientific epistemological views: The coherence with instruction and students' views. *Science Education*, 91, 222-243.
- U.S. Census Bureau. (2010). Retrieved from <http://www.census.gov/>
- U.S. Department of Education, National Center for Education Statistics. *Teacher Preparation and Professional Development: 2000*, NCES 2001-088, by Basmat Parsad, Laurie Lewis, and Elizabeth Farris. Project Officer: Bernard Greene. Washington, DC: 2001.
- Villegas, A. M. & Lucas, T. (2002). Preparing culturally responsive teachers rethinking

- the curriculum. *Journal of Teacher Education*, 53, 20-32.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Webber, A. (2004, February 23). Reverse brain drain threatens U.S. economy. *USA Today*. Retrieved from http://www.usatoday.com/news/opinion/editorials/2004-02-23-economy-edit_x.htm
- Weiss, R. (1994). *Learning from strangers; The art and method of qualitative interview studies*. New York, New York: The Free Press.
- Wise, Arthur. (2001). Chicago Sun-Times, September 7, 2001. <http://www.mailarchive.com/science@lists.csi.cps.k12.il.us/msg00708.html>
- Yin, R. K. (2011). *Applications of case study research*. Thousand Oaks, CA: Sage Publications.
- Young, E. (2010). Challenges to conceptualizing and actualizing culturally relevant pedagogy: How viable is the theory in classroom practice? *Journal of Teacher Education*, 61, 248-260.
- Zeichner, K. M. (1992). Educating teachers for cultural diversity. East Lansing, Michigan: National Center for Research on Teacher Learning, College of Education, Michigan State University.
- Zeichner, K. M. (1993). Traditions of practice in U.S. preservice teacher education programs. *Teaching and Teacher Education*, 9, 1-13.
- Zuniga, K., Olson, J. K., & Winter M. (2005). Science education for rural Latino/a

students: Course placement and success in science. *Journal of Research in Science Teaching*, 42, 376-402.

Appendix

Interview Questions and Probes

Please be aware that participation is voluntary and will involve minimal risk. The interviews will be audio taped. However, if at any point during the study you desire to discontinue the audio-taping process, end the interview, or withdraw from the study entirely, you are free to do so without penalty or consequence. If you choose to withdraw from the study, all information collected will be destroyed. You are not obligated to participate and your participation is voluntary. We are dedicated to maintaining confidentiality of information for all participants of the study. Therefore, the information you share will be confidential and your name will not be used in any discussion, presentation, or written document.

1. What contributed to your decision to be a science teacher?
2. Describe your greatest successes as a science teacher and what you believe contributed to them?
3. Tell me about your experiences teaching individual students or groups of students that did not engage well in science learning?
 - A. How would you describe these students?
4. Based on your experiences in science teaching, what are the challenges faced by members of historically underrepresented groups in the school's community?
5. Describe some of the students that presented the greatest challenges to your science instruction.
6. Describe some of the teaching methods and strategies you have used to engage students who seem difficult to engage in the learning process of science.

A. What has been successful?

B. What continues to challenge you in reaching all of your students?

7. What kind of supports do you feel you need to reach all your students maximally?

Note: Over recent years there has been increasing conversations within science education literature and science education organizations about diversity and multicultural education.

8. What is your understanding of diversity?

9. What is your understanding of multicultural education?

10. What do you believe it means to have a commitment to diversity and multicultural education in science teaching and learning?

11. In what ways do you incorporate science content related to the cultural background of your students?

12. What kinds of learning experiences including books/materials/authors you have read on the subject of multicultural education in science?

Background: There are groups that are historically underrepresented in science careers.

13. Why do you think that is the case?

14. How might science education change that pattern?

Note: Last question

15. What considerations do you think science teachers should reflect upon as they cross cultural borders in their classroom?

Request to Conduct Interview and Collect Demographic Data

1. Name, mailing address, and e-mail address of the investigator(s).

Ms. Yolanda Kirkpatrick

[REDACTED]

[REDACTED]

[REDACTED]

Email: [REDACTED]

2. Telephone number where the investigator(s) can be reached in the daytime.

[REDACTED] Office

[REDACTED]

[REDACTED] Cell Phone

3. Position(s) of the principal investigator(s) [undergraduate student, graduate student, or college professor (specify institution); [REDACTED] employee (specify job and location); other (specify occupation and affiliated institution, if any)].

Positions:

Doctoral Student, University of Tennessee Knoxville

[REDACTED]

4. Name and title of the principal investigator's instructor, major professor, or project director [if applicable].

Dr. Gina Barclay-McLaughlin

The University of Tennessee

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Email: [REDACTED]

Office Phone: [REDACTED]

5. Title of the proposed study.

Teacher Perceptions of their Science Teaching and Student Learning for Diverse Learners

6. Brief description of the proposed study which is not limited to but **must** include:

a) a purpose with the intended use of any data

My expectation is the knowledge from this study will inform our understanding of teacher involvement in science education and contribute to improving science instruction and student learning for all students. I especially hope this study will offer insights about science teaching, particularly for diverse learners, and support teachers and administrators to more effectively enhance science learning.

b) a targeted population (who and how many)

I request permission to interview science teachers [REDACTED]
[REDACTED]
[REDACTED].

c) data collection procedures

Audio taped interview

d) an estimated time required by [REDACTED] participants

The audio taped interview will require 30-60 minutes with a maximum of 2-4 total hours of participation.

- e) a statement indicating all data will be kept confidential and that all subjects and the system will be kept anonymous in any publication except when given written permission to mention the system by the research committee

Please be aware that participation is voluntary and will involve minimal risk. The interviews will be audio taped. However, if at any point during the study you desire to discontinue the audio-taping process, end the interview, or withdraw from the study entirely, you are free to do so without penalty or consequence. If you choose to withdraw from the study, all information collected will be destroyed. You are not obligated to participate and your participation is voluntary. We are dedicated to maintaining confidentiality of information for all participants of the study. Therefore, the information you share will be confidential and your name will not be used in any discussion, presentation, or written document.

- f) projected value of the study to [REDACTED], if any

We especially hope this study will offer new insights about science teaching and support teachers and administrators to more effectively enhance science learning.

7. Single copies of all questionnaires, surveys, tests, answer sheets, structured interviews, or other instruments that will be used by [REDACTED] participants. Each page needs to contain a statement indicating that all responses are voluntary.
8. Single copies of cover letters, copies of instructions, parent permission statements

(for voluntary student participation).

Students will not be participants in the study.

9. Approximate proposed times for the beginning and end of the study.

My plan is to seek volunteers and conduct interviews during the fall term. If

permission is received, I may have the school break to review and summarize the

interview responses and teacher demographic data.

Vita

Yolanda F. Kirkpatrick received her Bachelor of Science degree in Biology from Austin Peay State University, and her Master of Science degree in Microbiology from the University of Tennessee Knoxville. Yolanda's research interests are biological sciences, science education, and the cultural border crossing of teachers and students in these areas. She began her research as a research assistant at Vanderbilt University. Yolanda's teaching experiences include teaching of science classes at a math and science center, as a graduate teaching assistant, and twelve years at a community college in Tennessee. Further, she volunteered with AmeriCorps and the Children's Defense Fund, Stand for Children. Yolanda's future plans are to teach biological sciences and science education courses and continue doing research that is inclusive of perspectives of multicultural education and culturally responsive pedagogy.