SCIENCE AS A CRITICAL METHOD FOR DECONSTRUCTING DIVERSITY DISCOURSE: TOWARDS AN ANTI-RACIST TEACHER EDUCATION

by

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ABSTRACT

ALFRED ANTHONY ASH II. Science as a critical method for deconstructing diversity discourse: Towards an anti-racist teacher education.
(Under the direction of DR. GREG WIGGAN and DR. CHARLES B. HUTCHISON)

This study is informed by an understanding of cultural incongruities in the classroom, and a critical postmodern science framework that recognizes the need for an interpretive and incisive approach for teaching about diversity issues in teacher education. Driven by the ubiquitous presence of scientific innovation and global intersections of culture, a central concern in contemporary society is preparing a diverse and highly-skilled workforce. However, increasingly diverse student populations must contend with a demographically homogenous teaching force that is largely unprepared to teach them. While it is beyond the purview of science to address personal beliefs underlying such cultural disconnections, there remains an ability to identify likely causal relationships that offer important context for understanding student diversity; yet, little is known about its possible role in initiating meaningful discussions in this regard. This study explores the utility of science as a transdisciplinary, critical method for teaching diversity to preservice teachers (PSTs) and its potential for raising greater awareness about issues of race and ethnicity. To address this line of inquiry, a qualitative case study supported by multiple sources of evidence, including observations, questionnaires, interviews and a researcher-led class discussion was conducted with three PST courses at an urban research university. The goal of this qualitative research was to generate in-depth knowledge of ‘how’ and ‘why’ science might be valuable for teaching diversity, and thus to provide insight on an under-researched topic. Findings suggests that using

science to discuss diversity can, indeed, influence positive and inclusive PST practices that strengthen future student-teacher relations, and ultimately promote high academic performance in diverse settings.

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LIST OF ABBREVIATIONS

CPSP	critical postmodern science pedagogy
ESL	English as a second language
MEd	multicultural education
MSE	multicultural science education
PISA	Program for International Student Assessment
PST	preservice teacher
REC	race, ethnicity, and culture
TEP	Teacher Education Program
TIMSS	Trends in International Mathematics and Science Study

CHAPTER I: INTRODUCTION

In the seven decades following World War II, scientific innovation and population diversity have emerged as two of the most remarkable sociopolitical issues in the United States. While science has long been integral to human survival and progress, since the Soviet launch of Sputnik in 1957 it has come to permeate nearly every aspect of contemporary society (National Research Council [NRC], 2007a).[1] Increased applications of scientific knowledge have stimulated the creation of new industries, job growth, advances in healthcare, and methods to address environmental concerns (Tan, Barton, Gutiérrez, & Turner, 2012). Such advancements and prospects, however, belie the lack of U.S. workers trained to perform the highly-skilled tasks associated with the rising number of science, technology, engineering, and mathematics (STEM) professions vital to sustaining this growth, as well as the nation's global economic stability (NRC, 2007a).

Recent employment projections predict that, by 2018, approximately 90 percent of the fastest growing occupations that require at least a bachelor's degree will rely most heavily on workers with extensive training in science and mathematics, and who are able think critically to solve complex problems (Wang, 2013, p. 1082). However, because U.S. workers generally lack requisite knowledge in STEM disciplines that support the development of these skills, of the 123 million individuals needed to address this demand, only around 41 percent of the workforce will be adequately prepared to do so

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[1] This process began at the end of World War II in 1945. In particular, this process was triggered by the strategic advantage it afforded in the War and in ending the Space Race and the U.S. moon landing.

(Gordon, 2009; Wang, 2013). As a result, U.S. businesses have increasingly requested H-1B visas to bring in STEM-skilled foreigners to fill this gap. Between the years of 2001 and 2003 alone, the cap for the number of H-1B visas for highly-skilled foreigners rose from 65,000 to 195,000,[2] widening the legal immigration channel by 40 percent (Chen & Yoo, 2010; Lowell & Martin, 2012). The inability to address the need for STEM professionals internally is but one dimension of the challenges faced by the U.S. in securing the future of its citizens.

Accompanying this rather unsteady progression into the 21st-century is the racial and ethnic diversification of the U.S. population. In conjunction with the steady dissolution of institutional barriers throughout the 1950s and 1960s, the exponential presence of science in society helped to dramatically increase the number of cultural intersections, both in the U.S. and around the world. Facilitating this connection of people and ideas were developments in communication and transportation technology, which resulted in a surge of global migration, transnational dialogues, and interracial unions that increasingly blur the boundaries of race, ethnicity, language, and culture (Kellner, 2003, 2009; Lee & Bean, 2004, 2010; Smith & Edmonston, 1997; Wang, 2012). For instance, recent census data indicate that a majority of the 27 million individuals contributing to the 9.7 percent increase in the U.S. population between 2000 and 2010 reported being more than one race and speaking English as a second language, a course which demographers predict will extend to the year 2050 (Humes, Jones, & Ramirez, 2011; Smelser, Wilson, & Mitchell, 2001). This raises questions about the role of science

[2] Before dropping again after 2003 to 85,000, with an additional 20,000 available for those foreigners with advanced degrees.

for discussing issues of diversity, as well as the potential impacts this could have on promoting positive and inclusive teacher practices.

This rapid expansion of scientific innovation in the fields of medicine, information and communication technology,[3] and industry, along with the growing demographic heterogeneity is a strong indication that the global efficacy of the U.S. will necessarily rely on individuals from a variety of different racial, ethnic, and cultural backgrounds being trained in STEM fields. By extension, this places an enormous responsibility on the field of science education, which refers to "the scholarly and practical discipline concerned with the teaching, learning and assessment of science content, science processes and the nature of science" (McComas, 2013, p. 86). Though, despite being the fastest growing segment in the U.S., racial and ethnic minority students, particularly those from urban areas, are least likely to pursue a STEM degree (Bianchini, 2012). In response to such issues, a large and growing body of science education research has emerged, with the aim of raising STEM achievement and supporting the entry and persistence of underrepresented minorities in STEM areas (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2008; Hurtado, Newman, Tran, & Chang, 2010; Riegle-Crumb & King, 2010; Riegle-Crumb, Moore, & Ramos-Wada, 2011). Reports issued by the National Academy of Sciences echo the critical nature of these trends, and point to the need for substantial growth in the nation's workforce trained in STEM fields to support economic prosperity and high quality of life for this nation's citizens (NRC, 2007a, 2007b, 2010). Thus, in the ostensible pursuit of national security, economic

[3] e.g., telephones, radio, television, Internet, etc.

sustainability, and high quality of life,[4] the combined influences of science and diversity hold profound impacts for public education in the 21st century.[5]

Science Achievement and Teacher Preparation

As schools and society grow more diverse, the onus for preparing a democratic and critically-thinking workforce falls largely on the nation's future educators. In the interest of growing a diverse and competitive workforce for global economic sustainability, educational research has subsequently focused on teacher preparation (NRC, 2007a, 2007b, 2010; Riegle-Crumb & King, 2010). Due to this presumed link between education and the economy, teacher education programs (TEPs) have come under increased pressure to produce teachers who are able to engage students in diverse classrooms and prepare a highly-skilled workforce capable of addressing the nation's economic needs (Cochran-Smith, 2010; Cochran-Smith & Zeichner, 2009; Darling-Hammond, 2005, 2010; Osborne, Simon, & Collins, 2003).

To some degree, this perceived threat to the nation's social, economic and political efficacy in the global context is also due to the large investments in STEM education and research made by other nations (Bianchini, 2012). Literature on students' decisions to pursue a degree in STEM indicates that issues of access, equity, and relevance continue to have a crucial impact on their chances to secure employment in these areas (Chen, 2009; Correll, 2001; Nembhard, 2005; Riegle-Crumb & King, 2010; Xie & Shauman, 2003). This research has shown, for example, that students attending

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[4] The exponential presence of science in society is, arguably, more so a function of the unfinished project for techno-geopolitical dominance following the Second World War in 1945 (e.g., International Monetary Fund, World Bank, World Trade Organization to name a few).

[5] For example, federal legislation such as NDEA; high-stakes testing/accountability; and increased focus on URM in STEM

high schools in low-income urban areas tend to be ethnoracial minorities who do not feel academically prepared in science as they transition into postsecondary settings (Kozol, 2005; Lee, Robinson, & Sebastian, 2012). Moreover, these schools generally lack the resources needed for high student achievement, such as qualified teachers, classroom and laboratory materials for science competency, and culturally responsive instruction (Darling-Hammond, 2005; Gay, 2002; Johnson, Kahle, & Fargo, 2007; Kozol, 2005; Ladson-Billings, 1995a, 2009; Moscovici, 2008). Given this privation of resources, quality instruction, and opportunities that promote student achievement, the notion of a knowledge-based economy becomes especially troubling for diverse schools, and particularly for those in low-income urban communities (Darling-Hammond, 2005; Nembhard, 2005).

It is important to note, however, that low student achievement in racially diverse and/or underserved communities alone cannot explain the nation's overall middling STEM education programs and the underrepresentation of minorities in these fields. Nor does it explain the relatively underwhelming performance of American students on international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and Program in International Student Assessment (PISA) (Darling-Hammond, 2010; Organisation for Economic Co-operation and Development [OECD], 2011a, 2013a, 2014a). Where, even after controlling for socioeconomic (SES) backgrounds, as measured by the PISA index of social, cultural and economic status, U.S. students' science scores on PISA 2012 showed very little improvement (OECD 2014a, p. 230). While analyses of 2000 and 2009 PISA data show that controlling for SES did result in math and reading gains among 'socially-advantaged U.S. students,' that there

were increases of any significance simultaneously highlights issues of educational access and opportunity in this country (Carnoy & Rothstein, 2013; Rebell & Wolff, 2008). This, in spite of the fact that over the last decade the U.S. has been among the top five OECD countries in annual per-pupil expenditures (NCES, 2013a; OECD, 2013b, 2014b).

Fulfilling the need for STEM professionals is further complicated by low enrollment and persistence in STEM majors among native-born U.S. college students, especially those from diverse racial and ethnic backgrounds (Ehrenberg, 2010; Griffith, 2010; Price, 2010; Riegle-Crumb et al., 2011). In addition to the aforementioned labor deficit, low STEM enrollment is an important factor driving the increased number of H-1B visas requested by U.S. companies for foreign professionals trained in these areas (Gordon, 2009; Lowell & Martin, 2012; Wang, 2013).Varying levels of student preparation and prior educational experiences help to explain differences in their rates of persistence in attending colleges and universities (Griffith, 2010). In addition, enrollment in Advanced Placement Biology and Advanced Placement Chemistry significantly influence students' choice of attending a postsecondary institution and helps prepare them for the challenges of college science courses (Hoepner, 2010). Evidence also shows that high school students who enroll in the highest level courses in science are more likely to feel prepared in science regardless of their race or ethnicity (Tyson, Lee, Borman, & Hanson, 2007). However, recent data suggest that only around 16 percent of U.S. undergraduates receive science and engineering degrees, which contrasts with 47 percent in China, 38 percent in South Korea, and 27 percent in France (NRC, 2011, p. 49). Local and international metrics such as these underscore the reality that the U.S. consistently lags behind many so-called developed countries in terms of quantity and

quality of K–12 STEM education (Darling-Hammond, 2010; Ong, Wright, & Orfield, 2011, p. 173).

While nations such as China, South Korea, and France continue making rapid advances in science and technology-related fields, U.S. children's interest in and academic preparation for STEM careers appears to be declining (NRC, 2011; Ong et al., 2011; Osborne et al., 2003). Comparative assessments administered by PISA to 15-year-old students in 34 OECD countries as well as 31 others demonstrate that many nations are outperforming American students in science, math, reading; three subjects crucial to education and social mobility in a knowledge-based global economy (Cromley, 2009; OECD, 2011a, 2013a). PISA 2012 revealed, for example, that U.S. performance has declined in all three areas since 2009. Where, out of 65 countries,[6] in math, U.S. students dropped from 24th to 31st; from 20th to 24th in science; and from 11th to 21st in reading (OECD, 2011b, 2013a, 2014a). These results support TIMSS 2011 findings from student assessments in 59 countries, which indicate a strong, bi-directional influence of students' attitudes toward science and science achievement (Mullis, Martin, Foy, & Stanco, 2012). These data show that positive attitudes about science was a strong indicator for high science achievement, with converse also being true (Mullis et al., 2012). With respect to PISA science achievement, TIMSS findings further suggest that the poor performance could be attributed to the fact that, by Grade 8, the number of students with positive attitudes about science (i.e., factors such as interest, anxiety, perceived value, self-esteem and self-efficacy) has also declined (Mullis et al., 2012; Osborne et al., 2003).

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[6] 34 of which are affiliated with the Organisation for Economic Co-operation and Development (OECD)

Among other such indicators, TIMSS and PISA have prompted questions about the nation's comparative advantage in STEM, as well as the overall integrity of its educational system, particularly in the preparation of high-quality teachers (Darling-Hammond, 2005, 2010; OECD, 2011a). The consensus in science education scholarship is that thorough content knowledge is vital to preparing a highly-skilled, 21st century workforce (McConnell, Parker, & Eberhardt, 2013; NRC, 2007a; Wang, 2013). As demonstrated by TIMSS 2011, 4th and 8th grade students with experienced science teachers who are confident in the subject matter they taught tend to promote higher science achievement (Mullis et al., 2012). Along with implications of global economic sustainability and developing a strong democratic society, this emphasizes the need for high-quality K-12 science instruction centered on scientific literacy (NRC, 1996). The absence of which will ultimately affect citizens' ability to critically engage issues regarding the role of science in society in addressing healthcare, environmental, and energy-related issues (van Dijk, 2011, 2013, 2014). Subsequent reform efforts in science education positioned scientific inquiry as an essential component of science instruction for greater scientific literacy and proficiency (Park, Jang, Chen, & Jung, 2011).

Students involved in inquiry-based learning seek to understand scientific ideas as they occur in nature, as well as the methods by which scientists study these phenomena (NRC, 1996, p. 23). Science educators who teach from an inquiry perspective seek to create learning opportunities for students to develop evidence-based scientific questions and explanations (NRC, 1996, p. 29). In this sense, effective science teaching that consistently, if incrementally, moves toward science proficiency involves an active process in which students explore natural phenomena by generating questions and

theories related to their own personal experiences, as well as examine ideas generated within the larger scientific community (NRC, 1996; Park et al., 2011). To this end, in a 2007 report, members of the National Research Council (NRC) offer a framework K-8 science proficiency and curriculum design to help support classroom teachers in developing students' scientific literacy. The NRC's framework, comprised of four fundamental elements of learning, states that students who understand science:

1) Know, use, and interpret scientific explanations of the natural world.
2) Generate and evaluate scientific evidence and explanations.
3) Understand the nature and development of scientific knowledge.
4) Participate productively in scientific practices and discourse. (NRC, 2007c, p. 334)

The four learning strands encompassed by this framework are positioned as learning goals that address the types of scientific knowledge, reasoning skills, and practices essential for the development of students' scientific literacy, and thus their ability to demonstrate science proficiency. The development of science proficiency is most effective when the focus of curriculum and instructional design is on the interplay of these four strands, which requires strong content knowledge as well as the ability to deliver effective instruction (NRC, 2007c). Moreover, the demonstrable ability of scientific innovation to address societal needs suggests that scientific knowledge will continue to be a significant aspect of education in years to come. Yet, due to the lack of content knowledge, many science teachers are unable to support high levels of achievement among students who might otherwise pursue careers in science-related fields and contribute to in this capacity (Buczynski & Hansen, 2010; McConnell et al., 2013).

Johnson and Marx (2009) similarly argue that "science teacher quality is a concern because many science teachers feel that they were not prepared with adequate content knowledge or the instructional skills to teach science effectively" (p. 117). On the other hand, Hume and Berry (2011) report that science graduates may also contribute to poor teaching quality because they underestimate the cognitive demands and pedagogical reasoning needed to support student achievement. Thus it is unlikely that students will become proficient in science simply by developing pedagogical strategies or by subject matter content alone, which suggests that effective science teaching as a multidimensional endeavor that requires ongoing development (McComas, 2014; NRC, 2007c; Schneider & Plasman, 2011).

The growing complexity of issues related to science, society, and diversity has stimulated a considerable amount of research interested in culturally-responsive teacher preparation, as well as science teaching and learning (Atwater, 1996a; Cochran-Smith & Zeichner, 2009; Emdin, 2008a; Gay, 2002; King, 1991; Milner, 2006). And because science is still dominated by a male Eurocentric perspective, this literature has increasingly sought to address the need for a diverse and highly-skilled workforce through conceptual and pedagogical methods such as critical pedagogy, culturally relevant pedagogy (CRP), as well as multicultural science education (MSE) (Atwater, 1989, 1996a, 2011; Barton & McLaren, 2001; Basu & Barton, 2010; Hodson, 1993, 1999; Hodson & Dennick, 1994). In addition to exposing students from all backgrounds to STEM at an early age, this research suggests that using critical and culturally relevant approaches such as hip-hop to engage students, as well as place-based methods that integrates science into the community can help promote science achievement and thus

mitigate the underrepresentation of minorities in these areas (Barton & Berchini, 2013; Barton & Tan, 2010; Emdin, 2008a; Irby & Hall, 2010; Riegle-Crumb et al., 2011). While they tend to be domain-specific, these and other culturally inclusive curriculum enhancements and pedagogical methods are important aspects of supporting teacher preparation for minority student achievement in science as well as other content areas (Banks & Banks, 2004, 2010; Gay, 2002; Ladson-Billings, 1995b, 2006). What is not yet clear, however, is the potential impact of science as a transdisciplinary approach to initiate critical discussions about racial and ethnic diversity.

In general, the number and the success of TEPs that effectively prepare PSTs to teach in diverse settings is also unclear (Kumar & Hamer, 2012; Sleeter, 2001; Zeichner, 2003). Likewise, two decades of research on multicultural teacher education has at best produced ambiguous results. While some multicultural teacher education courses and related field experiences have impacted preservice teachers' dispositions in a positive way, others have shown little to no influence (Bennett, 2013; Delany-Barmann & Minner, 1997; Garmon, 2005; Ross & Smith, 1992; Sleeter, 2001). A majority of research suggests that PSTs are at the very least, underprepared for the diverse settings that many of them will enter upon graduation (Cho & DeCastro-Ambrosetti, 2005; Howard, 2006; Swartz, 2003). Among many possible explanations for the lack of progress, research suggest that this stems from: white PSTs entering TEPs with little cross-cultural and intercultural knowledge; infrequent or constrained discussions about race and ethnicity; and overly narrow applications of multicultural and culturally-responsive approaches that tend to elide more critical and comprehensive analyses of

human history (Carter, 2004; Cochran-Smith, 1995; Hickling-Hudson, 2004; King, 1991; Sleeter, 2001; Swartz, 2005).

Problem Statement

The central problem is that TEPs do not explicitly address many key issues needed for PSTs to develop deeper, more critical understandings of racial and ethnic diversity that support student agency and achievement in diverse settings. Student populations are increasingly diverse and yet the teaching force remains largely comprised of "[w]hite, monolingual, middle class, and female" whose lived experiences tend to be appreciably different from the student populations they serve (Banks & Banks, 2004; Brown, 2007; Milner, 2006, p. 344). Nearly 83 percent of the 3.85 million school teachers in the U.S. are white, 76 percent of whom are female, whereas the growing majority of students they teach are from various ethnoracial (ethnic/racial) backgrounds (National Center for Education Statistics [NCES], 2013b; Swartz, 2003). Research has consistently shown that many in this cohort often find it difficult to make the necessary connections to reach students with backgrounds disparate from their own (Delpit, 2006; Delpit & Dowdy, 2002; Gay, 2002, 2010; Howard, 2006). Whether the result of social or cultural misconceptions about race, many neophyte educators are not prepared to teach in diverse settings (Cho & DeCastro-Ambrosetti, 2005; Ladson-Billings, 2000; Swartz, 2003). However, as they complete their education programs, many PSTs will likely find jobs at diverse schools, where they will be surrounded by socioeconomic and cultural characteristics with which they are unfamiliar (Swartz, 2003). Thus, despite a clear demographic shift toward no single racial majority in the U.S., many PSTs will be ill-equipped meet the needs of this evolving society (Howard, 2006).

Implicit within these phenomena as well as the relative silence about issues of race and ethnicity in TEPs, is that the inadequate preparation of PSTs ultimately results in negative outcomes for non-white students. Multiracial and multicultural classrooms are increasingly led by teachers who find it difficult to reach their students; a costly disconnection that often results in poor instruction and low academic achievement (Brown, 2007; Delpit, 2006; Howard, 2006). The inability to connect with students in turn perpetuates educational inequality through what King (1991) refers to as "dysconscious racism," or the implicit sense of privilege and social dominance that engenders deficit-based thinking about the intellectual capacity of non-white students (Brown, 2007; Irvine & York, 1993; Milner, 2006). This suggests that understanding issues of race and ethnicity from a critical and contextual perspective is essential in preparing PSTs to teach diverse student populations. This becomes an especially relevant issue as classrooms become more racially, ethnically, culturally, and linguistically diverse, and almost concurrently, the proliferation of science and technology more intense. Little is known about how science might assist in addressing these concerns.

Despite an increasingly diverse social landscape of the U.S., and behind a veneer of tolerance and pluralism, many TEPs support a traditionalist model of schooling in which myths of meritocracy and colorblindness subsume the reality of limited educational opportunities for non-white students (Choi, 2008; Cochran-Smith, 1995; Croizet & Dutrévis, 2004; Darling-Hammond, 2005, 2010; deMarrais & LeCompte, 1998; Hickling-Hudson, 2004; Nembhard, 2005; Wiggan, 2007). In addition, TEPs may require only a single course on student diversity, which generally offers but a cursory examination of the various forces that have and continue to perpetuate racial inequality in

education (Brown, 2007; Cochran-Smith, 2003; Hickling-Hudson, 2004; King, 1991). Given that the majority of the nation's teachers are white and middle-class and teach a growing cross-section of the global population, coupled with uncritical assumptions of race, it is not unlikely that the resulting cultural mismatches between students and teachers elicit misconceptions of student ability (Howard, 2006; Swartz, 2003).

Science Mis-education

These cultural disconnections can be historically linked to social, political, and ideological myths and misconceptions used to stratify society on the basis of race and ethnicity. Whereas whites were traditionally regarded as the referential group, non-whites were considered intellectually inferior and morally impoverished (Combe, 1830; Marks, 2008; Wiggan, 2007). The duplicitous use of science to justify racial discrimination along such lines that contributed to social stratification through programs such as eugenics, and are still evident in education today. For instance, the long-debunked notion of race as a 'biological imperative' – whereby skin color is haphazardly linked to one's culture, or considered a determinant of intellectual capacity – remains embedded in schools and society, and receives the tacit endorsement of TEPs through the uncritical replication of dominant societal and cultural values (Bourdieu & Passeron, 1990; King, 1991; Mukhopadhyay & Henze, 2003; Smedley & Smedley, 2005). Such pejorative ways of thinking are most commonly promoted through the pervasive use of delimiting, implicitly racist achievement gap language uttered even among multicultural proponents (Hilliard, 2000; Ladson-Billings, 2006; Milner, 2012; Mukhopadhyay & Henze, 2003). Along with frequently negative media portrayal of non-whites, white preservice teachers are encouraged to adopt an implicitly reified deficit model of their students based on racial

and cultural stereotypes, in which success is "viewed as a deraced phenomenon achieved through meritocracy—if only individuals would try harder to do better" (Swartz, 2003, p. 256). The persistence of these cultural disconnections raises serious questions about the methods used in TEPs to prepare teachers for diverse settings.

Purpose Statement

Preparing students and teachers for the diverse tapestry of nations, ideas, and economies of a knowledge-driven and highly technical globalized world will invariably involve science. However, learning about and using science need not be confined to the science classroom, or as the means of production for vice and distraction from critical issues involving racial equality. Highly skilled but uncritical and historically myopic laborers will ultimately add little value to global society, and even less to themselves. The same being true for TEPs that do little to confront institutionalized forms of discrimination fixed by ideology, ignorance, or both (Cho & DeCastro-Ambrosetti, 2005; Howard, 2006; King, 1991; Swartz, 2003). In spite of much new knowledge in the field of education about teaching diversity, as well as increased attention about socioscientific issues such as biodiversity conservation and climate change, little has been said about the utility of science, across disciplines, to establish the basis of cultural relevance through our common humanity (Banks, 2004; Castro, 2010; Cochran-Smith & Zeichner, 2009; Gay, 2003; Milner, 2006; Sheets, 2005; van Dijk, 2013, 2014). This qualitative case study seeks to obtain data which will help to address this research gap.

The purpose of this study is to investigate the role of science in teaching about diversity to undergraduate PSTs, as well as how and why science might be used to address issues of race, ethnicity, and culture in their TEPs. Overall, the goal is to

determine the ability of science to deconstruct flawed narratives of race and human difference that have historically undermined racial parity in schools and society and legitimated pejorative assumptions of limited cognitive/academic ability of racial minority students. Three components were emphasized in this qualitative case study. The primary objective is to explore the role of science in teaching about diversity in undergraduate preservice teacher education programs. Investigating this phenomenon will involve analyzing multiple sources of evidence within a critical postmodern framework of science and diversity pedagogy. In addition, it aims to examine PST's perceptions of diversity before and after an instructional intervention to determine if, and/or to what extent, their views of diversity may have changed. Finally, using contemporary educational research on teacher preparation, it will employ ongoing and concluding analyses of data to determine how PSTs are being prepared to teach in diverse settings, and specifically, the potential utility of science in this pursuit.

In this regard, the present study advances that, when used as a catalyst for teaching about diversity, science can help unravel misconceptions about race by systematically engaging fundamental aspects of our shared humanity that evoke critical questions about racially discriminatory actions and discourse in schools and society. Embracing the notion of a common human origin of Africa would assist PSTs in creating more inclusive learning spaces, which has positive implications for student outcomes in classroom, and by extension, for humanity itself. Given the paucity of research on the use of science as a critical method for teaching diversity, this study is positioned to make an original contribution to a growing body of knowledge that examines the convergence of science, student diversity, and teacher education in the 21st century.

The Potential Role of Science

To inspire and to facilitate such critical analyses of diversity in teacher education, science must assume an alternate form; one that engages assumptions held by traditional science while forging a new path towards an antiracist teacher education. One fundamental assumption shared by scientists is that it can produce durable, though tentative scientific knowledge about the natural world. Not all questions can be answered through science, however, including concerns of personal and cultural beliefs or matters of good and evil. And yet, the ability to identify likely causal relationships using science helps provide context for such issues and in considering alternatives. In this sense, science can perform a vital function in education outside of the science classroom, as a critical response to the mis/under-education of preservice teachers.

A significant aspect of scientific knowledge driving this investigation involves human genetic variation in DNA, or deoxyribonucleic acid. Namely, that the sum of genetic variation in DNA between humans is said to exist only within 1/100th of a percent. This means that out of the 25 thousand specific genes[7] and 3 billion base pairs of DNA that comprise the human genome, humans are still roughly 99.9% the same. The remaining 0.01% of human genetic variation is responsible for physical differences, such as blood type, skin color, or eye color, as well as gene mutations that denote susceptibility to certain diseases (National Human Genome Research Institute [NHGRI], 2006; Smedley & Smedley, 2005).

This suggests two important, interrelated points about science and human diversity that would be informative in PST education. The first and perhaps most obvious

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[7] See also: Spencer Wells and the Human Genographic Project

of these is that humans are far more similar than they are different; that we are divided only by various phenotypical differences and cultural nuance. Thus, variations in skin color and other superficial features reflect distinct genetic adaptations to particular geographical regions, not an inherent social hierarchy. This leads to the second point, which raises questions about social understandings of culture. PSTs would also do well to understand that culture is not something biologically intrinsic to humans, but rather, a series of customized rituals reproduced and transmitted generationally through language and particular forms of symbolic representation (Harris, 1999; Marks, 1995; Smedley & Smedley, 2005). Indeed, knowing that humans are 99.9% similar presents the somewhat glaring implication that many of the presumed differences between humans are less biological, and more so ideologies of race that support social and cultural dominance. Given that the reasons and methods for stratifying society along the lines of race or other such measures of 'difference' amount to little more than social and cultural hubris, the development of greater critical awareness situated in our common humanity suggests that PSTs would be less susceptible to dysconscious racism in their future classrooms.

In this sense, the social construction of race, as a symbol of a cultural phenomenon of group dominance, is not an inherent feature of humanity itself (Donald, 1993; Winant, 2000). One implication being that social oppression is a complicit action, wherein the individual (inadvertently) participates in their own subjugation by adopting a discourse designed to oppress (Apple, 2000; Foucault, 1977, 1980). And further, that learned behaviors of social and cultural dominance, whether professed as empirical truth, or otherwise operating as a tool for discrimination and racism, are alterable through better understandings of race and ethnicity using critical applications of science (Smedley &

Smedley, 2005). Moreover, if social and cultural functions of a particular group are but external manifestations that group, then progress is only as valuable as the level of critique within a society – the extent to which the beliefs and actions of the group are questioned from within. Without thorough and ongoing critical investigations of the past, the concept of race will remain a socially debilitating cultural phenomenon for what will no doubt be a globally interconnected posterity. As this study seeks to demonstrate, the depth and scope of diversity discourse in TEPs is radically limited by the absence of such discussions, and critical analyses of racial inequalities could, in fact, be assisted through the use of science. In effect, science was positioned as a critical method for highlighting social, historical, and scientific inconsistencies and gaps of knowledge that willfully or otherwise perpetuate ideological myths and baseless legitimations for stratifying society. In addressing some of the inadequacies and related gaps in knowledge in teacher education, this study also seeks to contribute to the development of theories about critical science and diversity education by examining the transdisciplinary role and pedagogical impacts of science when used to teach about diversity in TEPs. Establishing a baseline for a critical dialogue in education that begins with a common humanity makes possible more inclusive and affirming discussions of race and ethnicity. Using science to initiate such discussions therefore has the potential to strengthen TEPs and assist in preparing PSTs for effective performance in diverse classroom settings.

When used as an instrument for critical appraisals of social constructs such as race, science establishes a basis for antiracist teacher education and a means by which to instill critical awareness about such issues among future educators. A critical scientific approach that systematically examines and documents historical shifts in understandings

of science and diversity is able to reveal how misguided ideological assumptions about human differences ultimately became a stratifying force in society. Further, using science to teach diversity in teacher education not only foregrounds a common humanity, which supports racial equality, but also addresses the growing need for a critically-thinking and scientifically literate workforce. The dearth of research on this topic underscores the need for studies that examine the extent to which such an approach would lend practical assistance in TEPs as well as K-12 education. A natural progression toward this end could therefore include the critical postmodern science pedagogy (CPSP) here proposed.

Research Questions

An antiracist CPSP, which is discussed in further detail in the following chapter, seeks to position science as a critical method to deconstruct and then initiate a new discourse of diversity education that foregrounds a common humanity with only varied cultural lenses that form our respective worldviews, such that new teachers might enter the classroom better prepared to reach students of all backgrounds. CPSP also supports several key features of the 21st century classroom, such as higher-order critical thinking, scientific literacy, and collaboration. A specific focus of CPSP in this investigation is using science to initiate discussions on race and culture in ways that illuminate and more deeply probe issues of racial and ethnic inequality than multicultural or culturally responsive strategies alone, which often escape larger critical analyses of humanity/human societies. An anticipated outcome is the development of a pedagogical method that supports effective teaching, and therefore, the students from diverse backgrounds that many PSTs will serve. Initial findings suggest that this method of teaching and inquiry into human differences has the potential of helping future teachers

better understand and therefore reconcile misconceptions of race and ethnicity that tend to diminish the quality of instruction and suppress student achievement.

To further investigate this issue a single case study was conducted, in which three undergraduate preservice teacher education courses at an urban research university in the Southeastern U.S. will serve as the unit of analysis. Using data collected from questionnaires, classroom observations, interviews, and responses during an instructional intervention, this study will explore the utility of science as a critical method to teach about diversity. To increase the quality of the study, data sources were triangulated and member-checking was used to validate participant responses. Along with ongoing data analyses, this qualitative study was guided by following research questions:

1) What is the role of science in teaching about diversity to undergraduate preservice teachers (at an urban research university in the Southeastern United States)?
2) How might this approach impact preservice teachers across disciplines in terms of raising greater critical awareness and influencing inclusive classroom practices?

Definition of Terms

Providing context and analysis generally requires the use of certain terminology for clarity, and thus, to adequately convey intent. To address the research questions within the social, historical and scientific contexts suggested by the line of inquiry in this study, the following section defines several terms used throughout the study.

Science

According to the American Association for the Advancement of Science (AAAS, 1993, 2010, p. 5), science refers to the "process of trying to figure out how the world works by making careful observations and trying to make sense of those observations," and rests on the premise that the universe is a unified network of consistent patterns of events and phenomena that can be understood through careful, systematic study. While this suggests a stable and coherent foundational reference for science, empirical studies have found that no such definition for a singular 'nature of science' exists (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002; McComas, 1998). Among science education researchers and the scientific community at-large, there is no consensus on a singular essence or nature of science; however, as suggested, there are areas of convergence that allow it to be a substantive area of inquiry (Abd-El-Khalick & Lederman, 2000; Bell & Lederman, 2003; Lederman, 1992; Lederman et al., 2002; McComas, 1998). These areas include processes that produce scientific knowledge, which inherently require scientific literacy (AAAS, 2010; Gilbert, 2004). Often, such concepts are obtained from science teachers who being learned about the content, nature, practices and process of science then communicate this information to students (McComas, 2013, p. 86).

Science Education

Science education, on the other hand, "extends beyond the generation of new scientific knowledge and effective classroom presentation of that knowledge" (McComas, 2013, p. 86). As earlier mentioned, this pursuit is concerned with teaching, learning and assessing the content, processes and nature of science; though, like the term science, there exists no singular definition of science education (McComas, 2013).

McComas (2013) contends that scientists, science teachers, and science educators represent three distinct aspects in the field of science and science education. Whereas scientists seek to explore and understand the natural world, and communicate resultant knowledge to other scientists, science teachers are charged with "knowing the content, nature and processes of science and effectively communicating such knowledge to students" (McComas, 2013, p. 86). Science educators, on the other hand;

> conduct research to address problems in science teaching and learning, develops policy statements, engage in informed political debate regarding the place of science instruction in schools and in society, educate future science teachers, and assess the state of science knowledge and understanding. (McComas, 2013, p. 86)

In this sense, science educators typify a unique blend of the characteristics of both scientists and science teachers. Moreover, as cognates of learning, teaching and practicing science, these areas are respectively embodied by the field of science education, in the quest to understand the natural world through the language or discourse of science. The fluency of which, is demonstrated through scientific literacy.

Scientific Literacy

Scientific literacy speaks directly to the ability to assess the significance of scientific and technical information. Not simply in terms of 'doing science' or creating scientific knowledge, but also the ability "to demonstrate a capacity to evaluate evidence; to distinguish theories from observations and to assess the level of certainty ascribed to the claims advanced" (Millar & Osborne, 1998, p. 5). Likewise, on the global stage, according to OECD and PISA standards, scientific literacy involves the use of scientific knowledge to draw conclusions based on given evidence in order to make decisions about

the natural world and changes it may undergo as a result of human activity (Gilbert, 2004). Situating science within increasingly globalized intersections of information, ideas, and cultures requires a baseline definition of diversity.

Diversity

To the extent that understandings of diversity are contingent on the social and cultural milieu in which it operates, the term itself can be multiply defined. According the National Council for Accreditation of Teacher Education (NCATE, 2011) Unit Standards, diversity is defined as "[d]ifferences among groups of people and individuals based on ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation, and geographical area," which suggests that diversity is also a contextual condition of community, not merely exceptionalities and difference (Lemke, 2001; Mansour & Wegerif, 2013a). In this sense, diversity is also precondition to human societies, albeit with very little homogeneity (Mansour & Wegerif, 2013a). While some features of diversity such as skin color are generally predetermined or fixed, the myriad of particular worldviews and beliefs are necessarily changeable (Mansour & Wegerif, 2013a; Sheets, 2005). In order to understand how it functions within the larger context of human activity, this study views diversity from both a social and scientific perspective, with an emphasis on race, ethnicity, and culture.

The social perspective of diversity in this study focuses on the interplay of race and ethnicity within the social context of schooling. Not to disregard or underplay sociocultural aspects such as gender, class, religion and linguistic differences, but instead to highlight one of many troubling aspects of human activity related to the features of diversity mentioned earlier (Pohan & Aguilar, 2001). The scientific notion of diversity is

equally as varied, and perhaps, similarly contested, which is due in part to a deluge of scientific neologisms that emerged throughout the late 20th century, such as 'biodiversity'(Kaennel, 1998). Although it varies across disciplines, the scientific notion of diversity in the biological sense generally refers to the multiplicity of various living organisms within and between ecosystems or other forms of either open or closed systems. Biological and ecological variability among the flora and fauna in an ecosystem is another aspect of this view of diversity, as well as genetic and genomic varieties of humans and other organisms (Hutchinson, 1959; Kaennel, 1998; Wilson, 1997).

Culture

While content knowledge and pedagogical skills are important facets of effective teaching, understanding the role of culture in learning is equally important (Gay, 2002; Shulman, 1986, 1987). Like diversity, culture is a term imbued with manifold interpretations. Throughout this investigation culture referred to "the ideations, symbols, behaviors, values, and beliefs that are shared by a human group" (Banks & Banks, 2010, p. 445; Wilson, 1998). From this perspective, culture denotes discrete transmissions of knowledge passed down from one generation to the next, and suggests that culture itself is a function of language, whereby societies not only create culture, as such, but are also created by its manifestations within society (Harris, 1999; Wilson, 1998). Thus it is a product; is historical; includes ideas, patterns, and values; is selective; is learned; is based upon symbols; and is an abstraction from behavior and the products of behavior (Wilson, 1998, p. 142).

Multiculturalism [Cultural Pluralism]

Inasmuch as language is a prominent feature of cultures and societies, increased cultural intersections resulting from scientific and technological innovations have galvanized efforts to create a new lexicon for discussing multiculturalism within the context of a pluralistic society. Multiculturalism generally refers to this condition of multiple cultures that exists in a common geographical region or community as a result of globalization;[8] however, it is also a "philosophical position and movement that assumes that the gender, ethnic, racial, and cultural diversity of a pluralistic society should be reflected in all of the institutionalized structures of educational institutions" (Banks & Banks, 2010, p. 447). Multiculturalism provides a curricular basis for multicultural education, which is defined as:

> a field of study designed to increase educational equity for all students that incorporates…content, concepts, principles, theories, and paradigms from history, the social and behavioral sciences, and particularly from ethnic studies and women's studies. (Banks & Banks, 2004, p. xii)

Significance of the Study

Among the concerns of the U.S. in a global society is how to effectively educate an increasingly diverse cohort of students in order to develop a highly-skilled, scientifically-literate workforce. Banks (2006) states, for example, that the "deepening ethnic texture, interracial tension, and conflict and the increasing percentage of students

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[8] According to Sahlberg, the term "globalization has typically been interpreted using economic, political and cultural terms" (Sahlberg, 2004, p. 65). Likewise, I use globalization to refer to "recent transformations of capital, labor, markets, communications, scientific and technological innovations, and ideas stretching out across the globe" (Carter, 2008).

who speak a first language other than English make multicultural education imperative in the 21st century" (p. xi). Given the exceeding complexity of the current geopolitical landscape, it is reasonable to suggest that the nation's ability to make sound, ethical decisions about the socioscientific issues influencing the course of humanity will necessarily rely on a diverse citizenry proficient in STEM disciplines such as science (Mansour & Wegerif, 2013; van Dijk, 2013, 2014).

Demographic differences between student and teacher populations and the effects of these cultural mismatches in the classroom that impact this intended trajectory are well-documented (Cochran-Smith & Zeichner, 2009; Delpit, 2006; Delpit & Dowdy, 2002; Howard, 2006; King, 1991; Ladson-Billings, 1995b). These understandings have driven a significant amount of research on preparing PSTs to teach diverse student populations using multicultural and culturally responsive approaches (Barnes, 2006; Bennett, 2013; Castro, 2010; Gay, 2002; Ladson-Billings, 2000; Milner, 2006; Sleeter, 2001). The absence of critical self-reflection among PSTs, however, continues to dampen efforts to develop positive and inclusive practices aimed at reaching students from diverse racial and ethnic backgrounds (Benton-Borghi & Chang, 2012; Gay, 2003; King, 1991). This lack of self-examination generally stems from and reinforces an all but imperceptible, internalized sense of privilege espoused by a traditionally dominant white culture (King, 1991; McIntosh, 1989). As a result, PST's misconceptions about the ability of students from racial and ethnic backgrounds different than their own continue to go largely unexamined in TEPs (Cochran-Smith & Zeichner, 2009; Howard, 2006).

Furthermore, in its best applications science has the ability to improve the quality of life of humankind (Tan et al., 2012). Thus, in response to the growing need for

scientifically literate citizens to sustain a knowledge-based society, an increasing number of studies have examined teacher preparation for diversity, though specifically, in science education (Atwater, 2011; Atwater, Russell, & Butler, 2013; Elmesky & Tobin, 2005; Jegede & Aikenhead, 1999; Lee, 2001, 2011; Lee & Fradd, 1998; Mansour & Wegerif, 2013b; Tan et al., 2012). This research suggests that science proficiency and critical applications of scientific knowledge are essential not only for addressing present and future concerns related to science, but also to support meaningful collaboration among diverse populations and viable participation needed to sustain a prosperous global democratic society (Mansour & Wegerif, 2013a). Each of these areas of research offer insights for addressing 21st century issues of science, (student) diversity, and (teacher) education. Yet, little is known about the role science might play in education outside of the science classroom, particularly as a critical, transdisciplinary method of preparing teachers for diverse settings. The present study seeks to investigate this phenomenon using a case study design, including participant observations, interviews, content analysis of questionnaires, and an instructional intervention that examines diversity issues of race and ethnicity from a scientific perspective. And because the utility of science as critical method for teaching about diversity is an understudied area, this case study research is uniquely positioned to contribute to the literature and knowledge base regarding 21st century teacher preparation.

In some ways, the ambiguity illustrated by the particular social and scientific views of ‘diversity’ in this study offers an alternate path for understanding student diversity. One in which a common humanity of cultural differences represents possibilities, rather than pathological ideologies of stratification (Wilber, 2000; Wilson,

1997). In other words, while distinct commonalities in the origins and processes of human activity may exist, the concept of diversity also represents an ability to adapt, and therefore the possibility of a more evolved discourse about race and ethnicity for a democratic society (Mansour & Wegerif, 2013b). Within this changeability and somewhat 'discursive nature of nature' is the implication that a critical science of diversity can provide a bridge to understanding social and cultural differences in education (Wilson, 1998).

The present study aims to explore the boundary between the social and natural sciences by examining the ways in which science and culture interact—a challenging, though important endeavor for education reform. To the degree that human behavior is a cultural transmission and our understandings of which influenced by if not contingent upon insights afforded by science, the cultural histories of humanity will, likewise, remain deeply entwined with this notion (Wilson, 1998). As Wilson observes, any misunderstandings therein come not from the lack of natural confluence between them; rather, such "misunderstandings arise from ignorance of the terrain, not from a fundamental difference in mentality" (Wilson, 1998, p. 138). One implication is that a critical lens that explores the scientific and sociocultural (i.e., genetic/biological, anthropological, geographical) histories of the human species may well support greater understanding and empathy in contemporary education – perhaps toward what could be thought of as an 'ecology of human equality.'

Delimitations

This research imposes the following delimitations: First, the study will examine undergraduate preservice teachers enrolled in courses that address issues of diversity, and

that are required by the teacher education program. Second, one urban research university in the Southeastern U.S. served as the research site for this case study. Lastly, the study investigated the role of science in teaching about diversity in the selected courses during the 2014-2015 academic year.

Limitations

The study examined one case of three undergraduate PST education courses bounded to one institution, to determine the role of science in teaching about diversity in teacher education programs (Creswell, 1998). Given the inherent currency of this topic about which little is known, the findings may be applicable beyond the boundaries of the present study. These limitations do not impinge on the quality of the study or its ability to respond to the research questions. Instead, by utilizing a single unit of analysis and small sample size, the design can be easily replicated and/or expanded. Moreover, this study could lay important groundwork for future research, including alternative applications of CPSP in professional development, curriculum development, and educational policy.

Summary

In this introductory chapter, interrelated issues of science and diversity were presented within the larger context of 21st century schools and society, which provided the basis for the present study. The problem this study sought to address was then outlined, which included research related to science and student diversity that demonstrated the importance of science in society as well as the need for effective teacher preparation to support the development of a diverse and highly-skilled future workforce. Also provided was the purpose of the study, the research questions guiding the study, and the study's significance. Given the profound implications of increasingly

diverse schools with a homogenous, if uncritical, teaching force and the growing need for a scientifically literate citizenry, U.S. students' underwhelming science achievement and the ineffectual preparation of teachers for diverse settings were emphasized as areas of concern. To this end, a qualitative case study that investigates the critical application of science to teach about diversity was proposed as a means to a more democratic and sustainable future in a knowledge-based global society.

The overall structure of this dissertation takes the form of five chapters, including this introductory chapter. Chapter two documents research that supports the study's driving inquiry and purpose. It begins by providing the theoretical dimensions and conceptual lens of critical postmodern science (pedagogy), through which the literature was analyzed, as was the remainder of the study. In doing so, chapter two highlights the need for a new discourse of diversity in teacher education with respect to: a) science, diversity, and the sociopolitical; b) multicultural and culturally-responsive approaches to teaching about diversity and difference; and d) the implications of using science as a critical method for teaching about diversity. In addition to providing context, this chapter reveals science as but an extension of society rather than the immutable monolith it is so often presumed to be. Only by humanizing it as such can science be put to purpose toward more critical and egalitarian ends in contemporary schools and society.

Chapter three provides the methodology used in this single case study, outlining the research method used to explore the potential role of science in teaching about diversity. It details the rationale for using a qualitative case study and describes the processes of data collection and analysis as well as the trustworthiness and limitations of the study. Chapter four presents the finding from the study. Chapter five offers an

analysis of these findings. The next chapter outlines the framework, context, and literature that support the relevance and significance of this study.

CHAPTER II: LITERATURE REVIEW

The aim of this investigation is to explore and thus better understand the potential role of science in teaching about diversity to undergraduate preservice teachers. An ancillary aim of this study is to determine how and why science might be used to address issues of race, ethnicity, and culture in teacher education programs (TEPs). Using elements of critical theory and postmodernism as a theoretical lens, this chapter reviews existing literature that addresses three key aspects of the study: a) science, diversity, and the sociopolitical; b) multicultural and culturally-responsive approaches to teaching about diversity and difference; and c) the implications of using science as a critical method for teaching about diversity. Particular attention is given to the exclusionary effects of racial discrimination, namely, the duplicitous use of science by traditionally dominant groups to subjugate individuals on the basis of phenotypic variations such as skin color. By documenting historical shifts in understandings about science and human diversity, misguided assumptions of human difference emerge that help explain how racial discrimination developed into such a pervasive and stratifying force in schools and society. Approached from a critical postmodern science pedagogy (CPSP) perspective, the sociohistorical context of science provides insights for teacher education programs.

As schools and society grow more diverse, the onus for preparing a democratic and critically-thinking workforce falls largely on the nation's future educators. Compounding the difficulty of this task is a public education system in which the sordid legacy of racial discrimination and social exclusion in this country persists. Investigations

of urban schools and communities illustrate a troubling picture of structural inequities and minority students who remain overrepresented in the number of dropouts, special education programs, and low education tracks (deMarrais & LeCompte, 1998; Green, 1999; Harry & Klingner, 2006; Kozol, 2005; Oakes, 2005). Much as they have since the 1970s, opportunity gaps and restrictions to social mobility resulting from racially motivated social dislocation, lack of (educational) resources, as well as low-quality instruction continue to disproportionately affect students in the nation's most underserved communities (Denton & Massey, 1993; Eggers & Massey, 1992; Kincheloe, 2010; Lipman, 2004; Massey & Eggers, 1990; Rebell & Wolff, 2008; Wacquant & Wilson, 1989; Wilson, 1991, 2010).

For the last thirty years or so, the juxtaposition of students from a diverse array of intersecting cultural and linguistic backgrounds with a culturally homogenous teaching force largely unprepared to teach them has prompted debates about effective teaching, as well as teaching in more culturally-responsive and equitable ways (Brown, 2007; Castro, 2010; Freire, 2005; Howard, 2006; King, 1991; Milner, 2006). This research is linked to the notion that teachers' pedagogical content knowledge (PCK) and cultural understandings, both of themselves and the students in their classrooms, are essential for effective teaching and high levels of student achievement (Gay, 2002; King, 1991; Ladson-Billings, 1995a; Shulman, 1986, 1987; Swartz, 2003).

Given the national and international focus on scientific innovation for its role in addressing present and future societal concerns and the underrepresentation of racial and ethnic minorities in science education and science-related professions, one implication is that more discussions about diversity are needed in 21st century science classrooms

(Parsons & Carlone, 2013). In light of this, many of these discussions include filling the nation's STEM-gap by increasing the number of members of 'underrepresented groups' such as women and racial minorities (Griffith, 2010; Hurtado et al., 2008, 2010; Lee, 2011; NRC, 2007a, 2010; National Science Board [NSB], 2007, 2010; Riegle-Crumb & King, 2010; Riegle-Crumb et al., 2011). Less often, but importantly, these discussions offer social critiques suggesting that preparing a diverse and scientifically literate workforce is achieved through greater awareness of the influences, and at times, dominance of culture in science learning and teaching (Aikenhead, 1996, 1997; Atwater, 1989, 2011; Atwater & Riley, 1993; Atwater et al., 2013; Barton & Yang, 2000; Jegede & Aikenhead, 1999; Lee, 2001; Noblit, 2013). Virtually absent among these debates, however, are implications for the role of science in initiating meaningful discussions of human diversity toward inclusive and transformative ends, whether inside or outside of the science classroom. To assist in filling this gap in the knowledge base about science and diversity in education, this study seeks to explore the utility of science as a transdisciplinary, critical method to teach about diversity issues such as race, ethnicity, and culture in teacher education programs (TEPs).

To situate the ensuing discussion, this chapter begins by presenting the critical postmodern framework through which issues of science and diversity in schools and society was examined. Next, a brief sociopolitical discussion illustrates how, traditionally, science was often misaligned as a metanarrative to serve the interests of the dominant class. Literature related to science and student diversity is then presented, including contributions, connections, and critiques of science and critical pedagogy, culturally relevant pedagogy (CRP), and multicultural education (MEd). The chapter

concludes with a new direction that employs science as a critical postmodern method to teach about diversity, along with several strategies that demonstrate what this approach might look like. The overall aim of which is to explore the possibility of science to deconstruct flawed narratives of race and human difference that have historically undermined racial parity in schools and society.

Theoretical Framework

To better position science and human diversity within the context of 21st education, this section outlines what is at present a heuristic framework of critical postmodern science pedagogy (CPSP), which draws from critical and postmodern theories in order to link science and diversity to their social and historical contingencies. The purpose of this framework is to assist in the deconstruction and interrogation of scientific knowledge, and in the critique of socially and racially discriminatory practices such as phrenology and eugenics that science has helped imbue within the public discourse (Parsons & Carlone, 2013). With the goal of human liberation, critical theory is a useful tool for questioning assumptions, as well as critical investigations of seemingly benign social and cultural patterns which are typically deemed so if only because of their prevalence or normative role in the functioning of society (Horkheimer, 1982). Postmodernism, on the other hand, denotes a skeptical atomization of categories that dissolves absolutes, focusing instead on the particulars of a social and historical moment, which in turn helps fill any contextual and conceptual gaps left by the broad, macrosocial perspective of societies and cultures afforded by critical perspectives, such as world-systems theory (Hopkins & Wallerstein, 1982; Horkheimer, 1982, 1993; Lyotard, 1984; Wallerstein, 1974, 2004). Thus, as Steinberg and Kincheloe (2010) contend:

> The synergy of the conversation between the postmodern critique and critical theory involves the interplay of the informed moral practice of criticality and the lenses of complexity of the counter-Cartesian domain. As it invokes its emancipatory system of meaning, critical theory provides postmodern modes of analysis with a normative grounding. (p. 140)

To this end, Steinberg and Kincheloe (2010) and Kincheloe and Berry (2004) promote the theoretical and methodological perspective of bricolage in educational research, which seeks to connect and extend the emancipatory project of critical theory toward the "egalitarian impulses of modernism" (Steinberg & Kincheloe, 2010, p. 141). Given the hybridity of cultures and styles in contemporary society, such reconceptualizations necessarily suggest a practical and theoretical extension to the postmodern (Best & Kellner, 1991, 2003). In the present study, these concepts are collectively applied in the examination of critical, culturally responsive, and multicultural forms of science pedagogy, and then deployed as a framework for exploring the role of science in teaching about diversity issues of race and ethnicity in PST education and its potential for raising awareness and promoting inclusive practices in TEPs.

Critical Theory

Critical theory is an invaluable theoretical perspective from which society can be examined for both hidden and overt oppressions enacted against any marginalized group, and through the social and cultural critiques it provides, supports the liberation of those enslaved by historical conditions arising out of capitalism (Horkheimer, 1982). Critical theory was popularized by cadre of social and cultural theorists whose theoretical school of thought was commonly known as the Frankfurt School, founded in Germany in 1923

at Institute for Social Research (*Institut für Sozialforschung*), and included Herbert Marcuse, Theodor Adorno, Max Horkheimer, Friedrich Pollock, Leo Lowenthal, Erich Fromm, Walter Benjamin, and later, Jürgen Habermas (Agger, 1991, p. 107; Blake & Masschelein, 2003; McLaren, 2007, p. 185). The principle mission of these intellectuals was reconceptualizing Marxian class analyses to better align with the cultural changes in 20th century society, ultimately beckoning a shift from the material contingencies of capitalism, toward social and cultural critiques of totalizing forms of alienation and 'false consciousness' (Agger, 1991). Hence, a critical social theory is a theoretical framework that argues against all manifestations of false consciousness, which reifies the notion of an inevitable, and rational social system at the expense of criticality in society (Agger, 1991; Alway, 1995; Blake & Masschelein, 2003; Horkheimer, 1982).

To Horkheimer (1993), substantive critical social theories are those that emancipate the individual, achieved through the ability to explain the shortcomings of the present; locate areas of social transformation and practical goals delineated by distinct analyses for doing so. This suggests two requisite tasks of critical social analysis. First, the manifold nature of oppression suggests that, to some extent, relational and historical context is necessary for developing a critical theory framework. The purpose of overcoming this challenge is to avoid wholesale condemnation of a particular group or myopic calls for a panacea to heal society. Second, because oppression is not isolated to a particular strata of society, critical social analyses must have the ability to operate at structural, cultural, and institutional levels, and with an interdisciplinary focus (Horkheimer, 1982, 1993). Moreover, critical social analyses merged with action define the basis from which critical theory seeks to liberate consciousness as well as the physical

self from alienation and societal oppression. Frankfurt School theorists sought to achieve this through the mechanisms of capitalism; i.e., to empower the human subject by way of interdisciplinary applications of information to create social consensus and return control over the democratic process in a capitalist society back to the individual (Horkheimer, 1982, 1993). In this sense, analyses that employ critical theory are focused on raising critical awareness of how power differentials manifest in society as well as an individual's tacit or direct complicity in the oppression of others, such as the use of race as an instrument of stratification in society.

The main political thrust of the Frankfurt School was to undermine the positivist science and the ideologies of reason that stemmed from the Enlightenment through human emancipation, including deterministic Marxian views as well as those held by so called traditional and social theorists such as Immanuel Kant, Auguste Comte, and Max Weber, by which the individual (proletariat laborer) was viewed as a passive rather than autonomous agent in society (Best & Kellner, 1991; Geuss, 1981; Horkheimer, 1982; Pleasants, 2002). This pursuit of critical theorists, argues Bohman (2005), marks the "horizon of critical social science" at which the "potentially self-defeating dialectic of freedom and power can be resolved…in the continuing process of democratization, which in turn requires a fuller understanding of the requirements of freedom in institutions," though beyond its boundaries of hyper-rationalization of oppression (p. 354). As Blake and Masschelein (2003) note that in rejecting absolute empiricism and rationalism, critical theory begins to "question the transparency of society to the individual consciousness, and with it, the transparency of self to self" (p. 44). Alway (1995) adds that it is "a politics informed by a vision of 'distinctness without domination,' a politics

of a plurality of agents, a multiplicity of actions, and a vastly expanded arena of political struggle" (p. 129).

In the context of the present study, this suggests that to be an effective medium for change, a critical theory must therefore confront issues of race as they are observed during analyses of the social condition. And further, that critical discussions about race can and should had at the very sites where injustice occurs, such as TEPs and schools (King, 1991; McLaren & Farahmandpur, 2001; McLaren, Martin, Farahmandpur, & Jaramillo, 2004). A contemporary example of a critical theory driven by social justice and racial equality is the related tradition of critical race theory (CRT), which centralizes race in analyses of institutionalized discrimination and its effects on social relations (Delgado & Stefancic, 2001). In what began in the 1970s as legal movement to expose juridical oppressions, often in the form of racially-charged ad hominem arguments that disproportionately affected minorities, CRT would ultimately influence the field of education (Bell, 1995a; Delgado & Stefancic, 2001; Ladson-Billings, 1998; Tate, 1997; Wallace & Brand, 2012).

Not all Frankfurt School thinkers held the same view of the purpose and function of critical theory, however. Wiggershaus (1995) argues there was never a unified critical theory originating from the Frankfurt School, but rather a series of related ideas centered around social and cultural critiques that borrowed from Marx's macrosocial economic analyses. He continues that, by the 1960s, the School had become an amalgam of the critical sociology of Adorno and Habermas (Adorno's research assistant), as well as earlier more radically-oriented social and critical Marxist ideas as when the Institute was led by Max Horkheimer (Wiggershaus, 1995). In spite of any internal transformations,

the Frankfurt School largely remained true to its mission of extending the Marxian critique of industrial capitalism in applying it to the social and cultural nuance of contemporary society, yet keeping intact the notion of a pragmatic, analytical philosophy grounded in society by the lived experiences of the members within it (Agger, 1991; Wiggershaus, 1995). Among the more notable departures from the original conception of critical theory, however, was that of Habermas (1972, 1984, 1987), whose ideas mark the boundary between the first and second generations of the School (Geuss, 1981; McCarthy, 1985; Pleasants, 2002; Wiggershaus, 1995).

Critiques by Habermas (1984, 1987) about the direction of the Frankfurt School are significant to the extent that his theories on the role of language in critical thought served as the initial rupture from the critical theory put forth during the burgeoning years of the School (Agger, 1991; Pleasants, 2002). Believing that 'Frankfurt School Critical Theory' had fallen victim to the metaphysical 'paradigm of the philosophy of consciousness' and idealist conception of instrumental reason as had Marx's analysis of political economy, Habermas posited a paradigmatic shift toward a theory of communicative action in its place (Gunderson, 2014; Habermas, 1984, 1987; Pleasants, 2002). This marked shift included the somewhat structuralist-leaning notion that the rationality of communication was a more effective means for achieving liberation than was the instrumental rationality and conflicted relationship with nature of first-generation critical theorists (Gunderson, 2014; Whitebook, 1979). And yet it was by this disengagement and foregrounding of language, as the means by which to disrupt manifestations of false consciousness, that further conceptualizing of critical theory was

accomplished (Agger, 1991; Habermas, 1984, 1987; Held, 1980; Honneth, 1979; McCarthy, 1985).

In the years since this break with Frankfurt School, various applications of critical social theory have emerged, including world systems, postcolonial and feminist permutations, many with pedagogical implications for multicultural education and science education (Capobianco, 2007; Carter, 2004, 2006; Feldman, 2001; Haraway, 1988, 1991, 2006; Hickling-Hudson, 2003; Johnson, Brown, Carlone, & Cuevas, 2011; Kellner, 1990; Sharpe, 2005; Wallerstein, 1974). As mentioned, this would increasingly include critical theories of social justice such as CRT, which sought to unveil racial inequality in the legal system through personal narratives that shifted the power back to the accused (Delgado, 1989). Though, as Kincheloe (2004) suggests, one of the earliest examples of critical theory scholarship aimed at 'rending the veil' of race, as it were, was that of 19th century urban sociologist W. E. B. Du Bois.

Evidenced by an intellectual legacy that includes such seminal works as *The Philadelphia Negro*, *The Souls of Black Folk*, and *The Conservation of Races*, Du Bois deftly confronted contrived, biological notions of race in 19th century America from a social and historical perspective (Du Bois, 1897, 1899, 1903). In *The Conservation of Races*, for instance, Du Bois (1897) implicates the very foundation of science for endorsing "the grosser physical differences of color, hair and bone" that "go but a short way toward explaining the different roles which groups of men have played in Human Progress," rather than investigating the "differences—subtle, delicate and elusive, though they may be—which have silently but definitely separated men into groups" (p. 8). Then, further articulating this position, he states that:

> While these subtle forces have generally followed the natural cleavage of common blood, descent and physical peculiarities, they have at other times swept across and ignored these. At all times, however, they have divided human beings into races, which, while they perhaps transcend scientific definition, nevertheless, are clearly defined to the eye of the Historian and Sociologist. If this be true, then the history of the world is the history, not of individuals, but of groups, not of nations, but of races, and he who ignores or seeks to override the race idea in human history ignores and overrides the central thought of all history. What, then, is a race? It is a vast family of human beings, generally of common blood and language, always of common history, traditions and impulses, who are both voluntarily and involuntarily striving together for the accomplishment of certain more or less vividly conceived ideals of life. (Du Bois, 1897, p. 8)

Du Bois thus concludes that "[s]o far at least as intellectual and moral aptitudes are concerned we ought to speak of civilizations where we now speak of races" (Du Bois, 1911, p. 158). Above all, Du Bois makes clear the need for, and indeed, the potential of applying critical perspectives in society, to the extent that his indefatigable criticality has informed present research in pursuit of uncovering the reprehensible effects of racism and discrimination on urban schools and communities (hayes, 2006; Kincheloe, 2004).

These theoretical positions respectively highlight implications of a society in which the Subject moves ever-closer to the emancipatory goals of critical social theory—to identify and confront institutionalized pathologies of social hierarchy as exercised through patriarchal capitalism and imperialist structuralism, and contesting such manifestations of oppression in local and global societies (Feldman, 2001). This reflects

what Wallerstein (1974) observes in his seminal work on world systems theory as the "ability to participate intelligently in the evolution of his own system is dependent on his ability to perceive the whole" (p. 10). Which is to say, that the particular (human, idea, etc.) is indeed connected, but only ephemerally bound, and should therefore be viewed as both whole and constitutive; as both macro- and micro-contextual; interrelated yet distinct (Feldman, 2001).

Moreover, owing to its conflict and critical antecedents such as Marx and the Frankfurt School, the similarities as well as divergences of these contemporary derivatives point to the inherent interdisciplinary appeal of critical theory in that it offers:

> a multidisciplinary approach for social theory which combines perspectives drawn from political economy, sociology, cultural theory, philosophy, anthropology, and history. It thus overcomes the fragmentation endemic to established academic disciplines in order to address issues of broader interest. (Kellner, 1990, p. 12)

With respect to educational research, the above suggests that it is a worthy endeavor to conduct analyses that seek to disrupt concentrations of power and privilege in order to create a more critical, egalitarian human relations. However, as Giroux (2004) and others have observed, the convergence of social, ideological, and technological forces in 21st century society have created a variety of more obfuscated threats of oppression and cultural hegemony that require new methods and a new language with which to engage the struggle of liberation (Giroux, 2004; Kanpol & McLaren, 1995a).

As the influence and implications of science and diversity in 21st-century society continue to expand further afield, it becomes clearer that today's youth occupy an altogether different world than what existed even a few decades ago. This is evidenced

not only by demographic and sociopolitical changes, but in the way they are able to engage this new world through various information and communication technologies (ICT) afforded by scientific innovation (Best & Kellner, 2003; Law, 2008). Likewise, technical rationalities now increasingly operate in plain view, within an ever-present neoliberal social scene driven by deregulated industry and free-market fundamentalism (Giroux, 2011; Giroux & Giroux, 2006).

Consider electronic devices such as computers, DVD players and cellular telephones, for example. Many have become staples in homes, schools and businesses; some with access to a global communication network comprised of equal parts information, entertainment and risk (Kahn & Kellner, 2003). Such innovations were made possible through scientific advances in ICT that produced the microprocessor[9] in the 1970s, which revolutionized the way digital bits of data were stored and retrieved (Noyce & Hoff, 1981). Microprocessors are small silicon chips containing "millions of transistors and other components that process millions of instructions per second" (Raymond et al., 2013, p. 488). Due to their small size and ability to perform complex computing functions at rapid speeds, microprocessors can be found in numerous household and personal electronic devices, as well as industrial applications such as transportation, high-tech medical devices and computer servers (Raymond et al., 2013).[10]

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[9] "A microprocessor is usually a silicon chip that contains millions of transistors and other components that process millions of instructions per second integrated with memory chips and other special purpose chips, and directed by software" (Raymond et al., 2013, p. 488).

[10] "Several items such as DVD players, cellular telephones, household appliances, car equipment, toys, light switches and dimmers, electrical circuit breakers, smoke alarms, battery packs, car keys, power tool and test instruments use microprocessors…industrial items with microprocessors include: cars, boats, planes, trucks, heavy machinery, gasoline pumps, credit-card processing units, traffic control devices, elevators, computer servers, most high tech medical devices, digital kiosks, security systems, surveillance systems and even some doors with automatic entry" (Raymond et al., 2013, p. 490).

And yet, despite their intended benefits some of the same products of these advances are used by the dominant class as social, political and economic tools of control (Hall, 1999; Kahn & Kellner, 2003; Kellner, 2003).

In a searing critique of high-stakes standardized testing in Chicago's public schools (CPS), Lipman (2004) demonstrates that the effects of which have become deeply entrenched in public policy. Her analysis implicates the strict accountability measures and disciplinary tactics of No Child Left Behind (NCLB) Act of 2001 as a major factor in the deskilling and disenfranchisement of teachers and administrators in underserved urban schools. In order to receive much-needed federal funding made available through NCLB, state education departments and school districts around the country were required to increase the number of assessments, and charged with collecting, managing and reporting massive amounts of data, in the way of test scores and student demographic information (Sunderman & Orfield, 2006).

In spite of NCLB's emphasis on school accountability and reform through state oversight, Sunderman and Orfield (2006) observed an overall dearth in professional and organizational infrastructure among state education departments in Arizona, California, Georgia, Illinois, New York and Virginia, suggesting that not all "state agencies have the resources, knowledge, and organizational capacity to intervene on the scale demanded by NCLB" (p. 532). School districts in states lacking the financial, human and technological resources (i.e., computers, etc.) to develop and implement the student information systems needed to meet the high data-reporting demand, faced deep interventions, and in some cases school closure (Sunderman & Orfield, 2006, pp. 547–548). Those that remained open did so under the panoptic threat of unemployment or further

disenfranchisement, forcibly narrowing the curriculum to the most basic components required to pass the tests and discouraging teachers and administrators from critically engaging issues of race and class inequality and marginalization (Lipman, 2004, p. 140). Moreover, with respect to students' differential learning experiences and levels prior exposure to the content on which they are assessed, Hilliard (2000) concludes that the perpetual focus on what are essentially invalid assessments, not only disempowers but conceals "a history of abuse of minorities and the poor" and continues to ignore the savage inequalities of schooling (p. 296).

Given the above, a critical perspective on the high-stakes era of education raises questions about the pervasive politics of science and social control in the form of an accountability regime obscured by data metrics that ostensibly support school reform (Hilliard, 2000; Lipman, 2004). Hilliard (2012) was led to consider whether standardized testing was part of "a quality control movement, as it is advertised, or…a decoy for something else" (p. 16). As it concerns this study, a critical perspective also draws our attention to broader themes regarding the role of science in schools and society. For instance, could it be applied as a critical method to teach about diversity? That is, could science be more than a techno-rational instrument of capitalism that transforms nature (students/teachers) into objects (data points) and divests human subjects of an inborn capacity and ontological vocation to be free—as in freedom? (Aronowitz, 1988; Freire, 1970; Horkheimer & Adorno, 1972).

A notable weakness of critical theory in this regard is its almost totemic posture, having a similar macrospective focus on the totality of society as had Marx is his economic class analyses (Mannheim, 1954). Critical theories are at times wont to wholly

engage the self-legitimating edifice of capitalism on the premise that while the new division of labor is deeply-codified as monetary success and social status, it is little more than an offshoot of the well-devised stratification of industrial society, and with a similar visage of natural fact—presented as though alienation should be desired and/or that it has always been the case—hence, the need for ongoing discussions of false consciousness (Aronowitz, 1988). However rightful, such analyses are also wont to overlook the accompanying notion that just as the bureaucratic force of capitalism has grown increasingly complex alongside the development of science and technology, so too has the language and instruments of oppression, by capital or any other such mechanism, become increasingly evasive and euphemistic in its attempts to conceal the message of domination (Aronowitz, 1988; Giroux, 2004). One implication is that, as a direct byproduct of the political economy of industrial modernism, critical theory alone is a rather cumbersome approach for engaging the rapidly changing social, scientific, and cultural backdrops of the 21st century that nearly demand contextualization, if they are to be acknowledged at all. Moreover, the oppressive advances of unfettered capitalism are no less stultifying in a global society; if anything, it has become more entwined with the notion of commonsense due in part to market-based social policies over the past several decades (Apple, 2010; Harvey, 2005; McLaren & Farahmandpur, 2001; Stiglitz, 2003). Thus, a Frankfurt School perspective might argue against any possibility of a reconciliation with science, even to teach diversity.

The class and market-based critiques offered by Marx and extended into the personal domain of the human subject by critical social theory are no less applicable in the general sense (Pleasants, 2002). Despite the powerful additives it offers for pursuing

human agency, however, because of its broad focus on historical materialism (i.e., the economic structures and processes by which human activity interacts with and is transformed by the social world) and subsequent lack of precision in the context of the particulars such as race—though, eventually, it would be brought to the fore by critical race theorists in legal studies (e.g., Bell, 1995a, 1995b; Delgado, 1989; Delgado & Stefancic, 2001) as well as in science education (e.g., Wallace & Brand, 2012)—critical theory is also constrained by a myopia in the form of perpetual re/negotiation of social contracts in contemporary society (Kellner, 1990; Marcuse, 2009; McLaren et al., 2004).

The Unintended, Critical Role of Science

Importantly, in 1961, Marcuse (2001) alluded to the possibility that social change could occur in a technological society precisely *because* the material line between the bourgeoisie and proletariat was blurred when scientific determinism and technology improved the living conditions of citizens around the globe, thus delivering them to the site of resistance itself, as McLaren has often argued regarding education (Moraes & McLaren, 2003). In arguing that the impending universalization of the rational dominance of science could somehow create spaces for social change, Marcuse makes a significant, yet paradoxical observation; that increased technical rationality of dominant society actually provides the very opportunity for social change. Moreover, he posits that the probability of the working-class will critique material inequities decreases proportionately with increases in technological improvement (e.g., medical advances since industrialism engendered more contact with dominant institutions, better health, and less alienation). As such, the social critique turns inward, forcing society to reexamine itself, as a collective, using the same instrumental mechanisms (i.e., technologies)

initially produced to increase capital (Marcuse, 2001). The implication is that these instruments of scientific domination could, in fact, contribute to the decline of the dominant structures that produced them—a resistance from within (Kellner, 2000).

For example, youth culture generally excoriated for their lack of participation and engagement with the larger world. It is presumed that they are disengaged because they are apathetic, oppositional, or otherwise non-compliant (Best & Kellner, 2003; Giroux, 2011; Kincheloe, 2011a). However, to Marcuse (2001), it may be more appropriate to say that recent influxes of technology, consumerism, and other forms of neoliberal profiteering (i.e., rational dominance) have only desensitized youth and deepened their false consciousness. Thus, while even traditionally marginalized (race, class, gender) groups in the U.S. are compelled to purchase gadgets, such as computers cell phones, televisions, car accessories, etc., their increasing desensitization is met by a critical awareness *within* the very confines of this fetishism of commodities (Kahn & Kellner, 2003; Kellner, 2003; Marcuse, 2001; Marx, 2009a, pp. 60-62). Despite being extrinsically urged to keep pace with the changing world, they may eventually encounter a point in their desensitization, in a collective false consciousness, where technology can become the very tool they use to disrupt the hegemonic forces that created them. In one example, many recent uprisings in Arab states were organized online using social media such as Facebook and Twitter where nearly 90 percent of Egyptian and Tunisian youth surveyed in March 2011 said that they used Facebook either to organize protests or raise public awareness about them (Huang, 2011).

Therefore, while what we ‘know’ is largely determined by external/material structures controlled by dominant forces, Marcuse (2001) and McLaren (2001) suggest

that when fetishism collapses, history and social consciousness folds onto itself in an awakening that reveals oppression (Hall, 1999; Kincheloe, 2008). Such that when understood in universal and in particular terms of and by the oppressed, they unite with each other, but more importantly, with themselves (re-humanized); this resistance from *within* rationally dominant structures lends insight for using science to teach about diversity (Kahn & Kellner, 2003; Kellner, 2003; Marcuse, 2001; McLaren, 2001). As such, this study proposes that if guided critical intentionality, science can have a similar impact on discussions of race and ethnicity in education. Where, for instance, advances of scientific knowledge about DNA and genetics liberate the closeted discourse about human diversity. However, this also suggests that without a strong pluralistic context of the social and historical, a critical science for teaching diversity would lack the sufficient interpretive fluidity with which to engage complex intersections of race and ethnicity in teacher education (Bauman, 2000; Collins, 2000).

Postmodernism

It is in such spaces, where the overlapping boundaries of labor divisions and social stratifications and in the interplay of worldviews that the role of postmodern can more clearly be seen as having a role beyond the aesthetic (Agger, 1991; Kellner, 1990). Yet to categorically define postmodernism is a task of futility; though, it may suffice to refer to it as a series of overlapping sociohistorical moments, a postindustrial condition following WWII, concerned with social and cultural departures from a so-called modern, industrial society (Derrida, 2009; Foucault, 2009; Hartsock, 1989; Lyotard, 1984). Jameson (1998) offers that, at the very least, postmodernism is often socially and temporally positioned around this time, which perhaps lends credence to the prevalent

notion of a post/modern binary. The term postmodernism has been applied in various cultural and aesthetic milieus over the last several decades, with an initial aim of blending and re/contextualizing modern elements of society into a more heterogeneous view of the world. In a general sense, Lyotard (1984) describes the postmodern as an "incredulity toward metanarratives," or skepticism of absolutes, and then, more specifically, he argues that "postmodern knowledge is not simply a tool of the authorities; it refines our sensitivity to differences and reinforces our ability to tolerate the incommensurable," and is thus a reaction to modernity and its project of self-legitimation (pp. xxiv-xxv). Many critiques using critical theory and postmodernism are fundamentally rooted in a similar discontent with the presumed certainty of logical positivism during the Enlightenment.

The Enlightenment marked what's referred to as the *humanistic* period, which lauded autonomous reason as the premise for social homogeneity and thus reductive claims of universalism. Embraced as such by these newly enlightened or 'emancipated' individuals, a schism with the theological tradition of absolute authority seemed inevitable.[11] Soon after would follow increased global travel, the slave trade, and other forms of trade and domination. Such that by the 1800s, the superfluity of the global slave trade had given way to industrialism and capitalism, and with it, a spirited attempt to organize society, and hence, modernity (Weber, 2009; Williams, 1944). This was due in part to an ethos of individualism that threatened solidarity, but also the need to control modes of production and direct the flow of capital (Durkheim, 2009a, 2009b; Hartsock, 1989; Lyotard, 1984; Marx, 2009b; Morrison, 1995; Mouffe & Holdengräber, 1989). For

[11] This refers to the 16th century dissolution of the Catholic church authority, propelled by Protestant reformers such as Martin Luther and John Calvin.

Weber (2001, 2009), the efficiency of which necessitated a merger of the calculable science of rationalization with religion, as axiological rejoinders to industrial capitalism.

As Aronowitz (1988) notes, the "rise of Protestantism in leading industrializing countries in the eighteenth and nineteenth centuries seemed to provide moral sanction for the preeminent position of modern science as knowledge," whereby religious institutions were regarded as the ethical riposte to the secular embellishments of money and power in industrial society, albeit conjoined with state authority (p. 9). And so, whereas artisanal and mechanical modes of production—by which raw materials were transformed into finished products—gradually succumbed to engineering research and practices involving electronics, physics and chemistry, scientific knowledge itself was institutionalized by the state as well as large corporations, thereby legitimating its role as the new order of 'truth' in society (Aronowitz, 1988). Hence, science was not only "a hegemonic ideology of the new social order of capitalism and its industrial stage"; it was now "integrated into the practices and discourses of production" that animated both the Protestant work ethic and state-supported capitalism at-large (Aronowitz, 1988, p. 9). Thus made possible in part through the political economy of the natural sciences, the effects of this scientific and technological shift toward hyper-rationalization and commodification are etched into contemporary society, where information has become product (Marcuse, 2001). In this sense, to control data/information is to control capital; a departure from physical alienation of industrial society, but similarly reliant on false consciousness and the pretense of a monocultural society in order to subsume the laborer/consumer (Lyotard, 2009; Marcuse, 2001).

With this context, a postmodern position is concerned with the cultural and sociohistorical conditions of post-modernity, where social, political, and cultural 'norms' were increasingly dissolved in favor of a more pluralistic worldview (Agger, 1991; Crotty, 1998; Jameson, 1998; Nicol, 2009). Though not entirely divorced from the so-called modern period, postmodernism nevertheless reflects a distinct philosophical and cultural shift from the totalizing discourses (e.g. culture, art, and literature) of modern industrialized culture of efficiency, to one of multiplicity and fluidity (Bauman, 2000; Beck, 1993). Put succinctly, the postmodern is a "disconcerting mixture of present, past, and future – or of cultural and spatial elements from these different times" (Lemert, 2009, p. 454). Moreover, and importantly, postmodernism rejects the 'violent hierarchies' and 'conceptual oppositions' assumed by the binary conflicts inherent within structuralism (e.g., language/text in Saussure), Marxism (e.g., bourgeois/proletariat) and abovementioned dialectics of critical theory, concerned as it is with subject/object and culture/nature distinctions (Aronowitz, 1988; Collins, 2000, p. 70; Derrida, 1978, 1982, pp. 41–42; Newman, 2001, p. 2). Such dichotomies imply that "[o]ne of the two terms governs the other (axiologically, logically, etc.), or has the upper hand" (Derrida, 1982, p. 41). As Collins (2000) explains, if "binary thinking…categorizes people, things, and ideas in terms of their difference from one another," then "[o]bjectification is central to this process of oppositional difference," and thus, a condition domination (p. 70). Thus it would appear that underlying the logic of binary oppositions there is an essentializing force (or center); a force which legitimates, as it creates, the very power structures of authority and oppression in society that critical theories seek to disinter, evident in the

objectification of subordinated groups, such as the delimiting, bifurcated language of a black/white achievement gap in education (Collins, 2000; Derrida, 1978, 1982).

For Derrida (1978) and Collins (2000), postmodernism does not presuppose a fixed center of objectivity from which such oppositional terms could even begin to produce stable meanings. A postmodern perspective seeks, therefore, neither to engage nor to replace these binaries as such, but rather, to deconstruct them; to overturn their hierarchical foundation; to displace them with a new concept "that can no longer be, and never could be, included in the previous regime" (Derrida, 1982, p. 41). For, to do otherwise, argues Derrida (1982), to omit this "phase" of deconstruction, is to also prevent "any means of *intervening* in the field effectively" (p. 41, original emphasis). And so, with no presumed 'grand narrative' guiding this heterogeneous style bent on decentering metaphysical universals, all discourses are provided conceptual space for their own truths/reality, and are thus imbued with a certain relativism devoid of clear distinctions or answers (Crotty, 1998; Derrida, 1978, 1982; Foucault, 1980, 1997).

In this way, postmodernism provides us with the mechanism for a conceptual shift in thinking that moves beyond the constrained dialectics of critical theory, toward envisioning science as a contested discourse within a matrices of social and historical forces rather than a dichotomous field of oppositions (Aronowitz, 1988). Though, given its traditional role as/within an institutionalized structure/discourse, Derrida (1978, p. 353) suggests that science must also "be thought of as a series of substitutions of center for center, as a linked chain of determinations of the center" ever seeking to reestablish itself as such (Derrida, 1982). Yet, as Newman (2001) observes, absent an "essential place of outside the system" from which to interrogate the "reflexive self-identity" of

philosophical or scientific claims, like Derrida, one is forced to work "*within* the discourse of Western philosophy [and science]…looking for hidden antagonisms that jeopardize," and thus, deconstruct its presumed authority (p. 2, original emphasis).

While this reliance on prevailing metaphysical discourse—to launch critiques within the very structures it aims to disassemble—is often construed as the fundamental deficiency of postmodernism, it also suggests the ability to entertain multiple perspectives of engages the notion of truth at a more fundamental level (Agger, 1991; Bohman, 2004). Multiple realities allow 'truth' to be situated within a particular social and historical moment, and thus examined more contextually for how and why certain 'truths' about race, embedded, for instance, as uncontested beliefs about black inferiority/white superiority, are allowed to remain intact in schools and society, despite being toxic functions of 'power' (Foucault, 1977; Hutchison, 2006; King, 1991, p. 187; Massey, 2004). Relatedly, for Agger (1991), postmodern social theory is generally conceived as having either an apologetic focus on social and cultural affectations of style and language, or a more critical bent that is decidedly more political. Critical postmodern social and educational theorists and researchers such as hooks (1990, 1994, 1999) and Kincheloe (2001, 2011a, 2011b) examine the social world through multiple lenses of marginality, including race, class, and gender and the kaleidoscope of intersecting oppressions that follow (Aronowitz & Giroux, 1991; Best & Kellner, 2003; Collins, 2000; Denzin, 1986; Giroux, 1991, 2004; Hartsock, 1989; hooks, 1990; Kilgore, 2004).

As will later be discussed, the postmodern position that there exists no absolute truth also helps explain the notion that 'truth is what power does.' Which is to say, truth itself is embedded in context and comes to be, or is granted, through consensus; it can

and does only carry a particular meaning relative to the 'truth-teller' and, in turn, their position of power and applications of said truth (Foucault, 1980). For instance, if a teacher accepts the unmerited and generally uncontested public consensus that non-white students are incapable of learning at high levels as true, then this 'racialized truth'—as the inculcated function of a common social discourse of white superiority that internalized over time—regardless of its legitimacy as democratic truth, is able to produce a harmful reality with tangible implications for the self-image and future performance of such students (deMarrais & LeCompte, 1998; King, 1991). Thus, by the same notion, the very fact that there exists alternate versions of 'reality' for PSTs, in which racial discrimination or biological determinism regarding one's intellectual capacity is, if only tacitly, accepted as just means for understanding students from diverse cultural backgrounds, suggests that to interrupt such misguided thinking necessitates an alternate truth/discourse socially and historically grounded in democratic freedom (Giroux, 2004; Mannheim, 1954).

In the interest of breaking this cycle, in *Ideology & Curriculum*, Apple (2004) employs a critical analytical method in social studies to demonstrate how power has been entrenched in the curriculum, with regard to topics such as trade unions. His critiques highlight mainstream attempts to defocus the curriculum and therefore elide contentious political issues, diffuses important discussions about the role of government in providing assistance to underserved populations (Apple, 2004). As an analog to this and other critical approaches to teaching about diversity (e.g., hooks, 1994; McFalls & Cobb-Roberts, 2001; Orlowski, 2011), the present study proposes that using generally accepted truths of science to develop a critical, rigorous method and discourse with which to better

understand and confront issues of human diversity in teacher education (Aronowitz, 1988). Kincheloe and Berry (2004) suggest such approach might involve the multi-layered perspective notion of *bricolage*. This research perspective involves context-specific interpretive inquiry that is connected to its participants, and offers a multi-paradigmatic approach and "a high-level cognitive process involving construction and reconstruction, contextual diagnosis, negotiation, and readjustment" (pp. 2-3). According to Kincheloe and Berry (2004), conceptualizing in research various domains of knowledge (e.g., philosophical, interpretive, narrative, semiotics, etc.) offers unlimited forms of discursive social, historical, cultural analyses, and poststructural critiques that can problematize otherwise monological research in multicultural, science, and teacher education. Thus, using various elements of critical theory and postmodern inquiry, this study aims to apply such multiperspectival analyses to explore the role of science in teaching about diversity.

Critical Postmodern Science (Pedagogy)

Despite notions of hybridity or plurality in research, a critical de/constructive framework of science and diversity nevertheless implies a certain level of logical critique and analysis (Kincheloe & Berry, 2004; St. Pierre, 2000). In the natural and social sciences this often takes on the form of positivist objectivity which, contrasted with a postmodern perspective, presumes that the influence of the observer and the observed can somehow be abstracted from an investigation of an issue or inquiry (Kvale, 2007; Patton, 1990). As Best and Kellner (1991) explain, postmodernism criticizes such positivist modernism "for its search for a foundation of knowledge, universalizing and totalizing claims, for its hubris to supply apodictic truth, and for its allegedly fallacious

rationalism" (p. 4). As such, it is important to delineate the usage of empiricism and objectivity as it was implemented in this study.

Whither Objectivism in Critical Postmodern Science?

The principles that underpin various scientific and philosophical traditions are products of their own social and historical contexts; each generation learns from the myopia of the last. Regardless of intent, any social endeavor that involves human interaction is susceptible to external influence by that very fact. Through a lens of critical postmodern science, instead of the purely intractable nature of objectivity conceived of during the Enlightenment, or the constitutive essence envisioned in the philosophical tradition of transcendental phenomenology, scientific 'knowledge' and 'truth' are (should be) highly contested areas to be deconstructed (Aronowitz, 1988; Foucault, 1980). With regard to this ontological instability of epistemology; i.e., the methods by which the truth of a thing is determined, Agger (1991) observes that a deconstructive science:

> continually raises its assumptions to full view and thus invites readers to join or challenge them…science no more than fiction can attain absolute truth, no matter how reflexive it is about its own values, assumptions, and methodological choices: Every deconstruction can be deconstructed. (p. 115)

In this sense, science is not relegated to a linear plane, but can be applied globally though under the condition that it remains self-interrogatory – of itself (Aronowitz, 1988). Here, the logic of science proposed by Popper (1966, 2002) may be informative. Popper (2002) offers the notion of 'inter-subjective testing and criticism' to decenter the idea of 'conviction' as a viable mode for establishing stable truth claims; he states that:

> a subjective experience, or a feeling of conviction, can never justify a scientific statement, and that within science it can play no part except that of an object of an empirical (a psychological) inquiry. No matter how intense a feeling of conviction it may be, it can never justify a statement. (p. 24)

To be objective in this sense, a 'scientific statement' is never absolute to the extent that it must be inter-subjectively testable; that it can infinitely undergo further testing on the empirical basis of this inter-subjective testability, from which other testable statements are able to be deduced. One statement tests the next, and so on. In other words, scientific knowledge is only stable insofar as it has reached that transitory precipice of inter-subjective testability, upon which it rests in wait for the next empirical line of questioning to gauge the a/symmetry of its truth claims. To Popper (2002), this method of deductive reasoning is also the best alternative to inductive reasoning, primarily because it holds no singular statement to be true in the universal sense in the first place. From this perspective, if an essence of a person or thing did exist, it would be more likely to emerge under such circumstances. Given this notion of the empirical objectivity (i.e., inter-subjective testability) of truth used in the ensuing discussion, it follows that any universal narrative, whether of an ideo/socio/teleo/logical, or otherwise political or scientific determinism, is (or should be) subjected to its own criticism if it is to contribute to the progress and not regress of democracy. This suggests a vision of science as the systematic process of ongoing self-interrogation of scientific knowledge and truth claims.

Of Truth: Power, Knowledge, and the (Self)Interrogation of Science

Foucault's (1980, 2002) writings on knowledge, truth and power provide some insight in this regard. Consider the following, for example: "'Truth' is to be understood as a system of ordered procedures for the production, regulation, distribution, circulation and operation of statements" (Foucault, 1980, p. 130). In his observations, Foucault (1980) similarly suggests an inter-subjective testability of discourse by acknowledging the fragility of objectivity in such statements, evident in his claim regarding truth and power; i.e., "what I am saying here is above all to be taken as a hypothesis...however, I would like to put forward a few 'propositions'- not firm assertions, but simply suggestions to be further tested and evaluated" (pp. 132-133). Yet, like Foucault's words, what is expressed is often branded to one's likeness – as ideology, as 'Truth' per se. However, for Foucault (1980) and Aronowitz (1988), 'Truth' is a situated scientific discourse conferred upon within the social, political, and economic institutions that produce and support it (e.g., education, military, media, and technology). Moreover, as a 'political economy of truth' it operates circularly within these systems of power, the effects of which extend into what Foucault (1980) refers to as a "regime of truth," directing the individual and society through tacit politics of truth; or the:

> types of discourse which it accepts and makes function as true; the mechanisms and instances which enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true. (p. 131)

Though, to Foucault (1980), political problems arising out the strained condition of scientific discourse and ideology are perhaps better understood in terms of 'truth' and 'power.' Beyond critiquing ideological impositions on science and society, or aligning it with another that is perhaps more palatable, as Foucault (1980) argues, the political issue is not merely "changing people's consciousnesses…but the political, economic, institutional regime of the production of truth" (p. 133). This does not involve whimsical attempts to emancipate truth from systems of power, but in the detachment of the power of truth from hegemonic apparatuses and redirecting it toward more transformative ends; to wit: "[t]he political question...is not error, illusion, alienated consciousness or ideology; it is truth itself" (Foucault, 1980, p. 133).

In this sense, the organic researcher and teacher intellectual, who seeks neither to hold nor to profess universal 'Truths,' is therefore positioned to confront and dismantle social apparatuses of systemic oppression and related truth claims to power, by virtue of one's relative position within the institution itself (Fischman & McLaren, 2005; Giroux, 1988; Gramsci, 1971). Even within the context of the classroom or scholarly inquiry, the potential of the teacher/researcher to exercise localized forms of power on the particular is always present, be it positive or negative. Thus, as Foucault (1980) warns, it would be a "dangerous error to discount [an individual] politically in [their] specific relation to a local form of power," particularly "on the grounds this is a specialist matter which doesn't concern the masses" (p. 131). A strong point made here by Foucault (1980) is that truth does not exist outside of power, nor does it lack in truth, as such. It is the *effects of power* that truth claims produce that should be of concern. And so, with respect to scientific or diversity discourse: truth is what power does.

As King (1991) and others (e.g., Gay, 2002; Hickling-Hudson, 2003, 2004; Hilliard, 2000; Hutchison, 2009) insightfully observe, PSTs and PST educators who, even if unintentionally, are unaware of the misleading 'truths' about race produced by and exercised through the power of internalized disregard, derision, or deficit-based thinking about students from diverse backgrounds can have significant implications for self-efficacy and academic performance. Viewed within a critical postmodern framework of science and diversity, here proposed as CPSP, through critical awareness and by purposeful positioning of oneself at the institutional levels of (teacher) education, such truth claims can be tested/falsified directly, and that the effects of power and in/direct sequestration of knowledge can be disrupted in the interest of critical social transformation (Foucault, 1980, 2002; Marcuse, 2009; McLaren, 1993; McLaren & Farahmandpur, 2001; Popper, 1966, 2002). In the absence of such an ability to critique knowledge claims from these localized positions, the vacuum it leaves behind will almost certainly be filled with hollow 'convictions' in the form of silent statements that indiscriminately oppress in the interest, rather than the critique of social power, yet to the detriment of society. In the deafening silence of such convictions, Nacimento (2007, p. 34) reminds us of both the imperative and obstacles for emancipation:

> To offer subordinated identity equal footing to compete in this democratic game, it is necessary to break the [effects of the] hegemony of the dominant identity, Eurocentric whiteness, constructed so solidly and so well reinforced that it reigns silent without being perceived. (p. 34)

In this study, which aimed to explore the role of science in teaching about diversity, the use of scientific knowledge was neither regarded, nor presented, as some

new inflection of an already essentializing force. As it is in the scientific community, this approach seeks no absolute truth, but rather, truth through critically informed consensus, which can be contested when it no longer responds to a given set of circumstances (AAAS, 2010; Aronowitz, 1988; NRC, 1996; Popper, 1996, 2002). In this sense, was used as a critical and re/constructive method for teacher education with which to critique not only sociopolitical aspects of race and pluralism, operating under what McLaren (1997) refers to as the "discursive mantle of diversity," but also scientific discourse, and through this de/construction and decentralization, the oppressive truth claims about race and ethnicity, therein (McLaren, as cited in Nascimento, 2007, p. 34).

As earlier suggested, many truth claims about the intelligence and cognitive ability of minority students stem from unexamined truth claims made under the aegis of scientific knowledge (Marks, 1995, 2008; Wiggan, 2007). While not all subscribe to these 'truths,' the emanation of such ideologies from institutional seats of power have no less allowed them to manifest in society, perforce, as 'Truth.' Drawing from a critical postmodern perspective of science, this study aims to unveil and decenter oppressive discourses by de/constructing new ways of using science in schools and society. In positing a common humanity that arose out of the African continent, it explores the notion of a critical postmodern science pedagogy (CPSP) of human diversity as a reflexive and transformative activity in which specious claims of science and society about diversity are interrogated, as well as the domain of science itself.

Science, Diversity and the Sociopolitical

The conceptual lens of CPSP discussed above was used to examine educational literature that supports the driving inquiry and purpose of this study, which is to explore

the role of science in teaching about diversity to PSTs, as well as the potential of this CPSP to influence positive and inclusive teacher practices. In what follows, a brief social and historical context of science and diversity is provided through a CPSP lens, which illustrates some of the traditional misuses of institutionalized truth claims framed through dominant cultural ideology as absolute. Particular attention is given in this discussion to the exclusionary effects of racial discrimination through the duplicitous use of science by traditionally dominant groups to subjugate individuals on the basis of phenotypic variations such as skin color. By documenting historical shifts in understandings about science and human diversity, misguided assumptions of human difference emerge that help explain how racial discrimination developed into such a pervasive and stratifying force in schools and society. From a critical postmodern scientific perspective, historical critiques of repressive ideologies embedded in science and society provides insights for teaching about diversity in TEPs toward more inclusive, positive and emancipatory ends.

Ideology

The concept of 'ideology' is deeply interred within sociopolitical discussions. It is as politically-charged as it is perplexing, in that carries a variety of assumptions and etymological baggage depending on its usage (Eagleton, 1991). Eagleton (1991) describes the word ideology as "a text, woven of a whole tissues of different conceptual strands…traced through by divergent histories," and offers several definitions to capture some of its myriad meanings:

- the process of production of meanings, signs and values in social life;
- a body of ideas characteristic of a particular social group or class;
- ideas which help to legitimate a dominant political power;
- false ideas which help to legitimate a dominant political power;
- systematically distorted communication;
- that which offers a position for a subject;

- forms of thought motivated by social interests;
- identity thinking;
- socially necessary illusions;
- the conjuncture of discourse and power;
- the medium in which conscious social actors make sense of their world;
- action-oriented sets of beliefs;
- the confusion of linguistic and phenomenal reality;
- semiotic closure;
- the indispensable medium in which individuals live out their relations to a social structure;
- the process whereby social life is converted to a natural reality. (pp. 1-2)

Given the apparently ubiquitous yet contrary 'ideations of ideology,' it is important to outline more precisely the denotative assumptions operating in the present discussion, as well as the study itself (Eagleton, 1991). In all, the present study is concerned with the notion of ideology in terms of "true and false cognition, with ideology as illusion, distortion and mystification," as well as "the function of ideas within social life" (Eagleton, 1991, p. 3). Moreover, with respect to what Mannheim (1954) suggests in his treatise on the sociology of knowledge are its local and global (i.e., micro- and macrolevel) dimensions of ideology—relative to its locus within society as well as that of the social subject, ideology has both particular and total forms.

From a critical postmodern perspective, ideology in the global sense is envisioned as an oppositional force in society at-large that functions primarily to allay attempts to deconstruct and subvert authoritative power or to deter disaffected thinking among its members. This is achieved by way of imposing dominant cultural values, the result of which is often a false consciousness that inhabits the mind of uncritical subjects only to obscure the distinction between structure and agency, though, presumably, for some greater good (Apple, 1978; Kumashiro, 2008; Mannheim, 1954). Local ideologies point to individualized perspectives of social actors derived from their lived experiences that

are, at once, obscured by illusions of autonomy within their respective conceptual and cultural schemas, while also tethered to a sense of allegiance if not reliance upon totalizing forms of ideology (Mannheim, 1954). In this way, personal ideologies are often skewed, if not sublimated, by the larger ideological mechanisms perpetuated by hegemonic cultural values/views in society, such as race, class, age, sex, and gender discrimination. This suggests that macroscopic (global, critical theory, society-based, educational) and microscopic (localized, postmodern, schools and classroom) aspects of positionality and respective influences of ideology on them have significant implications for teacher education, to which a multiperspectival lens such as CPSP could be applied in order to grasp confront such issues more directly.

In other words, the pervasive nature of ideology in education is such that both the flow and the direction of (scientific) knowledge is inarguably influenced by social institutions and discourse, as well as the historical context in which they are situated (Foucault, 2002, 2003). For instance, while supported by the traditionally dominant cultural ideologies of Eurocentrism, deficit-based perceptions inhibits critical learning opportunities for the PST, and ultimately, the personal growth and academic performance of non-white students in their future classrooms. From this perspective, how and what knowledge is transmitted and received during formal and informal learning processes necessarily affects the re/formation and re/production of cultural values and identity in a society (Bourdieu & Passeron, 1990; deMarrais & LeCompte, 1998; Foucault, 2002, 2003). Whether through public debate, political platform, or media, and in nearly self-regulated fashion, such discursive practices form the parameters and referential measures by which value is ascribed to various forms of knowledge (Foucault, 1977, 1980, 2002).

Given that education is one of the most effective means to transmit (or deny) knowledge, racism and discrimination remain both socially and culturally situated within the social context of education, as well as reproduced through the language and processes of schooling (Altbach, 1971; Apple, 1978, 1993; deMarrais & LeCompte, 1998; Foucault, 1980). However, as Mannheim (1954) argues, in that "[t]he ideas expressed by the subject are thus regarded as functions of his existence," the onus for reconciling ideological oppositions falls back on the social actor (p. 50). This suggests that, with or without their awareness, PSTs are ultimately accountable for the ideological implications of conscious or dysconscious racism in the classroom (King 1991). Inasmuch as the depth and scope of diversity discourse in TEPs is radically limited by this apparent absence of critical analyses race and racial inequalities, CPSP is presented as a viable move toward more antiracist forms of teacher education. As such, this study seeks to explore CPSP as a means to empower PSTs as critical social actors who by confronting misguided historical assertions about race and centralizing the notion of a common African origin, resist the false consciousness and compliance inherent in the silent, yet pernicious, discourse of student diversity in TEPs.

Omissions and Mis/Appropriations of Science

History provides several examples of attempts to legitimate discriminatory practices against non-white ethnic groups by appropriating the narratives of science and culture (Foeman, 2009). Lacking the epistemological variability of cultural influences, science tends to draw exclusively from a Eurocentric worldview. This view forms the basis of Western Modern Science (WMS), and creates a Eurocentric metanarrative of humanity that bends decisively toward that particular cultural group (Corsiglia & Snively,

2001; Quigley, 2009; Shizha, 2010). In the shadow of WMS, often conspicuously omitted from the discourse and tomes of historical and scientific knowledge are the many contributions of non-white cultures, such as the Ethiopian descendants of Ancient Egypt, or Kemet,[12] to science and medicine, as well as mathematics, philosophy, religion, and various aesthetics (Asante, 1990, 2000; Ben-Jochannan, 1973, 1991; Diop, 1974, 1981). One such omission is also a misattribution. While modern medicine is generally traced back to the Grecian, Hippocrates (c. 460 BCE – c. 370 BCE), the so-called father of medicine, its origins extend much further into the past, to his African predecessor and first scientist named Imhotep. Imhotep was a chief official, vizier, physician, as well as chief architect of the Step Pyramid at Saqqara under King Netjerykhet (Djoser), ruler of Ancient Egypt/Kemet during the 3rd Dynasty (c. 2980 BCE – c. 2650 BCE) (Asante, 2000; Brandt-Rauf & Brandt-Rauf, 1987; Diop, 1981; Hurry, 1926; Osler, 1921; The British Medical Journal, 1927). Much to the consternation of classical scholars (e.g., Lefkowitz, 1997), who prefer to centralize Europeans as the progenitors of and most significant contributors to civilization, critical applications of scientific inquiry and research rightly challenge such notions (Bernal, 1996).

Critical interrogations of Eurocentric world history reveal, for instance, that not only is Hippocrates erroneously positioned as the forebear of modern medicine, but a preponderance of evidence also suggests that early Ancient Egyptians most closely resemble ‘black’ individuals from Sub-Saharan Africa (Asante, 1990, 2000; Ben-Jochannan, 1991; Bernal, 1987; Brandt-Rauf & Brandt-Rauf, 1987; Diop, 1954, 1974,

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[12] Kemet, var. KMT; kmt  , is term derived from Pharaonic language of the Ancient Egyptians, and was used to indicate blackness of the earth and the people of Africa (Diop, 1981, pp. 41-43).

1981; Hilliard, 1986, 1992; Hilliard, Williams, & Damali, 1987; United Nations Educational, Scientific and Cultural Organization [UNESCO] 1974, 1978). Many of these topics are still perceived as a threat to Eurocentric values or, at best, contentious misalignments of history. However, as Cheikh Anta Diop (1954, 1974, 1981) demonstrated in his pioneering, multidisciplinary work that linked Ancient Egypt to Sub-Saharan African culture,[13] using scientific inquiry to critique scientific inquiry is invariably significant for revealing commonly overlooked cultural contributions and historical facts.[14]

For instance, in 1974, Diop and colleague, Théophile Obenga, participated in a symposium hosted by UNESCO in Cairo, called "The Peopling of Ancient Egypt and the Deciphering of the Meriotic Script," held partly at Diop's urging. Transcripts show how scholars critical of Diop's work tirelessly attempted to upend his thoughtful erudition. The result of the three day scholarly exercise was said to be inconclusive; although, the transcript suggest otherwise. It was clear that Diop was well prepared to defend his thesis, as he repeatedly justified his position, noting among other evidence the distinct physiognomy, art, racial and linguistic characteristics that necessarily qualify Egypt as an African civilization. Interestingly, the symposium report concludes with a rather shocking statement of what amounts to forfeiture on behalf of the scholars who had for three days opposed Diop's work:

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[13] Diop's PhD dissertation was so controversial that it took several years and the support of scholars from a variety of fields to convince the institution of the validity of his work.

[14] Mannheim (1954) suggests that investigation history (or, to Foucault, the effects of power) may be the closest one could come to taking an objective view (i.e., dispassionate; transcendental) of data.

> Although the preparatory working paper…gave particulars of what was desired, not all participants had prepared communications comparable with the painstakingly researched contributions of Professors Cheikh Anta Diop and Obenga. There was consequently a real lack of balance in the discussions. (UNESCO, 1974, p. 102)

The results of this conference demonstrate the force of ideology and its sociohistorical influence on science. Namely, presenting historical facts acquired using scientific methods was unable to dissuade members of the scientific community from clinging to ideological convictions of European preeminence in Antiquity. Such mis/appropriations raise questions about how ideology became so entwined with science and also point to influences of the academy on pseudoscience and scientific racism.

Pseudoscience and Scientific Racism

In an information-based age, various forms of knowledge are more easily compiled and transmitted around the globe. However, the rapid proliferation of ideas and information has not been without conflict and distortion. Then, as now, many non-white cultures suffer in search of human rights and equality, while the vestiges of hegemonic ideologies about race seek to sustain a metanarrative in which the values and appearance of one cultural group is privileged above all others. One method of such distorting information to favor the traditional Eurocentric framework of truth is through pseudoscience, and more generally, by privileging scientific knowledge acquired through WMS over other forms of knowing. Pseudoscience refers to methodologically flawed practices or otherwise ineffectual logic that presumes scientific authority. Whereas, scientific racism proposes that the human species is naturally divided, and exists as such,

on the basis of an inherent gradation of human value. Since it emerged around the late-17th century, this line of pseudoscientific thinking has been used to maintain racial fallacies, and therefore, to justify racial inequality through misguided ideologies presented as scientific knowledge (Foeman, 2009; Marks, 2008).

By the 19th century, being propelled by the burgeoning force of industry and capital, science had solidly become an instrument of authority used to legitimate social stratification on the basis of race and ethnicity. Among the remaining political bastions of white-hetero-patriarchy is the long-debunked argument of race as a biological imperative, as well as the pejorative "conflation of homosexuality and pathology" (Marks, 1996; Omi & Winant, 1994; Terry, 1997, p. 272; Witzig, 1996). Due to misguided assertions of genetic or phenotypic variability embodied by pseudoscientific racist practices such as phrenology and eugenics, science has since been instrumental in reinforcing dominant group ideological values and under the auspices of sound empirical research. For instance, 19th century craniologists used the racially discriminatory practice of phrenology to classify morality and intelligence based on the features of an individuals' skull.[15] In effect, however, science was contorted through the prevailing cultural ideology of white supremacy into a form of pseudoscience by which the intelligence and "force of

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[15] "The brains of the different EUROPEAN NATIONS differ considerably from each other, but a common type characterizes them all, and distinguishes them from those now described. They are decidedly larger than the Hindoo, American Indian, and Negro heads; and this indicates superior force of mental character. The portion before the ear, connected with the intellectual faculties, and the coronal region, or the organs of the moral sentiments, are more amply developed in proportion to the base and posterior inferior parts of the brain, the organs of the animal propensities. In short, they indicate a higher natural power of reflection, and a greater natural tendency to justice, benevolence, veneration, and refinement, than the others. The organs in which the European brain in an especial degree excels, are, Ideality, Conscientiousness, Causality, and Wit. The organs of these faculties are almost invariably small in barbarous and savage tribes. The European skull belongs to the Caucasian variety of Blumenbach, which he considers as the most beautiful and perfect of all the national crania in the world; and in this point he and the phrenologists agree" (Combe, 1830).

mental character" of non-whites was erroneously held to be deficient, and the individuals themselves deemed inferior to whites (Combe, 1830; Marks, 2008; Wiggan, 2007). Eugenics[16] doctrines of the 19th and 20th centuries similarly attempted to show a causal link between race and intelligence to support such claims (Herrnstein & Murray, 1994; Hilliard, 2000; Marks, 2008; Wiggan, 2007).

Fallaciously conflated with the evolutionary theories of species diversity postulated by Charles Darwin, as well as Gregor Mendel's genetics studies, eugenics became an increasingly popular, "scientifically credible" basis for social and racial stratification (Bouchard, 1988; Marks, 1996; Ordover, 2003). Though aimed at 'national hygiene,' and ostensibly verified by scientific studies as well as Francis Galton's mathematical explanations of intelligence, phrenology and eugenics did far more to legitimate racial, class, gender, and sexuality bias and exclusion (Collins, 1998; Marks, 2008; McKnight, 1997; Ordover, 2003; Proctor, 1988). As a result, countless generations have endured subjugation, discrimination and miseducation, if only to redirect public discourse away from the development of critical consciousness to challenge the hardline views of sociopolitical and ideological fundamentalists that have traditionally been at odds with science and society about issues such as race, class, gender and sexuality (Collins, 1998; Noble, 1993; Omi & Winant, 1994; Ordover, 2003; Rosario, 1997).

Pseudoscience versus Authentic Science

Despite masquerading as genuine scientific practice, such mis/applications of science that serve the interest of a few to the detriment of many reveal the synthetic basis of pseudoscience. By contrast, authentic science consists of inquiry-based practices in

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[16] The term eugenics was coined by Darwin's cousin, Francis Galton (Proctor, 1988).

which evidence and logic are used to examine natural phenomena and develop comprehensive explanations regarding their occurrence. This generally involves real-world applications of scientific inquiry and problem-solving methods that position scientific knowledge as the basis of everyday life (Crawford, 2014; NRC, 2012). Using a CPSP lens, the present discussion extends this notion of authentic science to include a more complex arrangement of social and political issues aimed at addressing problems in local and global societies (Buxton, 2010; Eilks, Nielsen, & Hofstein, 2014). For instance, an authentic CPSP suggests the need to apply scientific knowledge toward the advancement of a diverse, democratic society and committed efforts to provide adequate healthcare, nutrition, and sanitary living conditions for all global citizens.[17]

As demonstrated in previous sections, the inauthenticity of pseudoscience is often buttressed by an uncritical reliance on a fundamentally racist ideology. Viewed through Popper's (1963) eventually favored lens of critical rationalism which dispossesses the idea that knowledge itself could ever be fully apprehended, the principal criterion for determining the true authenticity of a scientific theory is "its falsifiability, or refutability, or testability" (p. 37). This line of demarcation is conceptualized as the extent to which a scientific hypothesis or theory can be systematically disproven. In this regard, to genuinely test a scientific theory should involve the willful attempt to falsify or refute the stability of the claim itself. Thus, as opposed to pseudo-rationalism[18] and other logically untenable, 'uncritical or comprehensive' forms of ir/rational faith in reason, Popper

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[17] Especially considering that this country has allocated nearly $500 billion for defense spending for 2015 fiscal year: http://www.gpo.gov/fdsys/pkg/BUDGET-2015-BUD/pdf/BUDGET-2015-BUD-6.pdf

[18] For Popper (1966), pseudo-rationalism is "the immodest belief in one's superior intellectual gifts, the claim to be initiated, to know with certainty, and with authority" adopted by Plato and others (p. 433).

(1963, 1966) concludes that only evidence resulting from such self-critical tests of refutability can help produce truly authentic scientific knowledge.

Kuhn (1962), on the other hand, argues that falsifiability is, in fact, a false-choice; that scientific knowledge is made real through the social activities of discovery and scientific consensus following a paradigm shift, from which new scientific ideas emerge. This view asserts that science is not concerned with falsification, as such, but rather the revolutionary ideas that disrupt normative paradigms of the scientific knowledge it precedes (Kuhn, 1962). By decentering this normativity, authentic science is, in the Kuhnian sense, postmodern, in that it rejects the coherence and telos of fixity of normal or traditional science "in favor of multiplicity, plurality, fragmentation, and indeterminacy" (Best & Kellner, 1991, p. 5). At the outset, it is tethered to an incommensurable narrative of 'normal science' striving only to validate its own claims, only to become beleaguered by the drift, crisis, and revolution of discovery followed by a groundswell of scientific practice that initiates a paradigm shift toward new understandings (Kuhn, 1962). From a CPSP perspective, Kuhn's (1962) observations are important as it shows how authentic science can originate (and exist) beyond the borders of the social institution of science and scientific research, a point less evident in Popper's (1963) work until much later.

Further, and importantly, a CPSP perspective suggests that, in spite of any conflicts arising between Popper's insistence on refutability (or criticism) and Kuhn's paradigmatic pendulum of discovery, pseudoscience is rendered ineffectual by either conception of authentic science practice. For instance, a significant point of departure of pseudoscience from authentic science is marked by its non sequiturs and base attempts to

reify the primacy of whites at the expense of racial minorities, purportedly for the 'greater good' of society. Here, both Popper's (1963) criterion of demarcation and Kuhn's (1962) scientific revolution threaten the pseudoscience of phrenology and eugenics which, above all, seek to escape any such refutation or change as it would only expose the inherently hollow bias of racial superiority upon which their claims rest.

In part the response to such critical views of science and society, the argument of white superiority has moved from blatantly racist explanations of intelligence offered by Combe (1830) and other 19th century pseudoscientists to more contemporary and sophisticated theses as that presented by Herrnstein & Murray (1994), which more or less masks a similar assertion using statistics and psychology. However, these untenable discussions do not go unaddressed. For instance, amid public debates surrounding Herrnstein & Murray's (1994) notion of an incidentally white, "cognitive elite" in *The Bell Curve*, which in many ways served to subtly reify the archaic notions that intelligence is somehow biologically determined by one's race, or is at best the byproduct of an inescapable cycle of inheritable poverty, the American Anthropological Association (AAA) put forth the following statement:

> WHEREAS all human beings are members of one species, *Homo sapiens*, and
>
> WHEREAS, differentiating species into biologically defined "races" has proven meaningless and unscientific as a way of explaining variation (whether in intelligence or other traits),
>
> THEREFORE, the American Anthropological Association urges the academy, our political leaders and our communities to affirm, without distraction by mistaken claims of racially determined intelligence, the common stake in assuring equal

> opportunity, in respecting diversity and in securing a harmonious quality of life for all people. (AAA, 1994)

Despite the scientific community's opposition against these vestiges of (scientific) racism and a host of scholars in education, sociology, and psychology who point out methodological and analytical flaws in studies such as Herrnstein and Murray's (1994), which was found to measure the amount of academic instruction one has received rather than inherent ability, such baseless arguments still exist, albeit discussed in more subtle and evasive ways than in centuries past (Devlin, Fienberg, Resnick, & Roeder, 1997; Fischer, 1996; Gould, 1996; Hilliard, 2000).

These examples illustrate how science (read: pseudoscience) is embraced by the dominant class when it serves to legitimate and solidify traditional Eurocentric power structures. The ignoble history of such attempts to legitimate the superiority of whites on the basis of pseudoscience demonstrates the depths to which scientific racism was rooted in the academy. In this sense, scientific racism is the function of reified ideological power structures in society, and the deepening false consciousness. Interestingly, when science is used to challenge those same ideological structures the institution resists. However, as Atwater (2010) suggests, each instance of suppressed scientific discovery and critical discourse begs the simple yet complex question of "who benefits?" Who benefits when critical appraisals of social institutions are silenced by the clamor of ideology? Who benefits when advancements facilitated by science that could otherwise offer equity in education and quality of life are suppressed? These are questions that (science) teachers should be prepared to ask in order to uncover racial discrimination in curricula and in instructional practice (Atwater, 2010).

Next Steps

Given the sociopolitical context highlighted above, it is clear that scientific knowledge is highly implicated in the struggle for racial equality in the United States. Indeed, the social and historical contingencies of science illustrate the lack of the presumed value-neutrality of science, instead emphasizing that it is one of many narratives with particular truths about the natural world. Further, the suppression and instrumental role of science in shaping social institutions to secure positions of power for a few also suggests that the language and the application of scientific discourse is a contested domain (Foucault, 1980; Hodson, 1993, 1999). While, from a critical postmodern perspective, the ongoing interrogation of scientific knowledge and discourse in society supports the ability of science to provide context to our shared human experience; thus, in order to transcend itself, it must critique itself.

What follows is a critical analysis and synthesis of literature associated with the questions driving this investigation: 1) What is the role of science in teaching about diversity, particularly in TEPs?; and, 2) How might such an approach impact PSTs across disciplines, in terms of raising greater critical awareness and influencing inclusive classroom practices? However, research on using science to teach about diversity in educational settings is limited. The selected literature will therefore address educational issues that focus on student diversity and their integration with science. The literature is organized into three major themes followed by the positioning of critical postmodern science pedagogy in the body of knowledge on teaching about diversity issues in the 21st century. It is important to again note that the use of the term diversity is here concerned with race, ethnicity and culture. Related issues of discrimination in society such as class,

gender, sexuality, and language are also important aspects of human diversity and should be acknowledged as such. However, the latter issues are beyond the scope of the present discussion, which is specifically concerned with the role of science in teaching about race, ethnicity, and culture. Moreover, this new direction seeks to build on current research in the science and student diversity literature.

Review of Literature on Science, (Student) Diversity, and (Teacher) Education

During the same historical period as the ascendant role of scientific and technological innovation and diversification of society, social movements and educational reform efforts aimed at mitigating the effects of racial discrimination in schools and society were also emerging. Consistent with the ubiquitous presence of science, rapid demographic shifts, and issues of equity and social justice over the past several decades, this section discusses key areas of research involving science, diversity, and education. These interrelated topics are commonly discussed in the context of multicultural, culturally relevant, and critical perspectives of schools and society. This research rightly focuses on conceptualizing methods for practice that increase students' and teachers' critical awareness of diversity issues of race, class, gender, language, ability, and cultural epistemologies in the classroom and in local/global societies (Abrams, Taylor, & Guo, 2013; Apple, 2010, 2011a, 2011b; Castro, 2010; Freire, 2005; Giroux, 1988; Shizha, 2010; Swartz, 2003).

As a broad rubric for diversity and teacher education, the framework of and application of CPSP that grounds this research underscores three major themes in the literature, with a particular emphasis on science, diversity and education. The more critical varieties are related to the first theme of critical (science) pedagogy, from which

culturally relevant pedagogy and multicultural education were largely developed (Cochran-Smith & Zeichner, 2009; Lee & Buxton, 2008). Critical perspectives in teacher education and science education literature are decidedly more political and tend to centralize concepts such as critical consciousness, emancipation, agency, social justice, and place (Atwater, 1996a, 1996b; Atwater & Riley, 1993; Barton & Yang, 2000; Buxton, 2010; Cochran-Smith, 2010; Hickling-Hudson, 2004; Kanpol & McLaren, 1995b; Ladson-Billings, 1995a; May, 1999; Tsurusaki, Barton, Tan, Koch, & Contento, 2013). Along with the two additional themes that address culturally relevant (science) pedagogy and multicultural (science) education, this research has increasingly included feminist, postcolonial, and postmodern critiques that open the field to new conceptualizations of learning and teaching diversity through science (Capobianco, 2007; Carter, 2004, 2006; Haraway, 1988; Hickling-Hudson, 2003; Sharpe, 2005). While these topics may differ in scope and application, their shared commitment to social justice and the empowerment of racially and ethnically marginalized groups through critical and engaging teacher education and science education offer significant insights for teaching diversity to PSTs.

A common thread throughout this discussion is the notion that critical, pluralistic, and human-responsive forms of science education and teacher education may also have implications beyond the science classroom. In particular, the following review suggests that teaching diversity using science involves developing critical educators who, because they are attentive to both student and community contexts (i.e., race, ethnicity, culture, etc.) as well as wider political implications of ‘mainstream’ science (i.e., norms of science), continually seek to enhance curriculum and instruction in ways that are more

responsive and inclusive (Barton & McLaren, 2001; Basu & Barton, 2010; Hodson, 1999). Moreover, given the lack of research on science as a critical method for teaching diversity to PSTs or otherwise, this literature will provide a basis from which to explore and analyze the implications of CPSP and thus respond to the research questions, here restated: 1) What is the role of science in teaching about diversity to undergraduate preservice teachers (at an urban research university in the Southeastern United States)?; and 2) How might this approach impact preservice teachers across disciplines in terms of raising greater critical awareness and influencing inclusive classroom practices?

Critical Pedagogy and Science

Given its focus on marginalized and underserved populations, critical pedagogy is often associated with multicultural, culturally relevant/responsive, and antiracist approaches to teaching and learning science (Atwater, 2010, p. 20; Gill & Levidow, 1987; Hodson & Dennick, 1994). Similar to the 20th century progressive conceptualizations of an authentic, democratic, and constructivist education, critical pedagogy in science education presents knowledge as student-centered and co-constructed (by student and teacher), and poses problems in 'real-world' contexts relative to the various cultural epistemologies brought into the classroom (Dewey, 1916; Freire, 1970, 2005; Popkewitz, 1998; Ültanir, 2012). The ultimate goal is to develop transformative intellectuals instilled with hope, driven to resist social oppressions of all kinds, and grounded in the historical struggle for human agency and radical democracy through education and student-centered dialogue (Giroux, 1988, 2005; Kanpol, 1992; Kanpol & McLaren, 1995b; McLaren, 1999). This often takes on a deeply political, emancipatory quality by which students, teachers, and educational researchers develop a

critical consciousness and awareness to locate inequalities in society, and through these informed critiques assist in empowering the human subject as a social agent (Bandura, 1989, 1999, 2001; Canella, 2007; Freire, 1970; Kanpol & McLaren, 1995b).

From this perspective, a critical science pedagogy suggests profound implications for unearthing latent forms of repression by confronting dominant narratives of racial stratification through scientific inquiry and investigation (Atwater, 1996b; Barton & McLaren, 2001; Basu & Barton, 2010). Rather than "depositing" scientific information into students simply to assuage the schooling demand in this high-stakes era of testing and accountability, critical science pedagogy emphasizes an ongoing dialogue that challenges hegemonic societal forces by framing subject content within relevant social, cultural, and political contexts of a particular historical moment (Freire, 1970; Lipman, 2004). When centralizing and empowering the student/subject as such, science is revealed not as a concrete, but as a fluid and contestable domain. However, correcting or "rewriting" social distortions that create material inequities in society relies on critical literacy, which is itself a creative and political act of knowledge, or "an effort to read the world" in order to emerge as a counterhegemonic force to level hierarchies (Freire, 2005; Freire & Macedo, 1987, p. 29).

In his study on appropriating the discourse of science, Brown (2006) examined the role of language in science, and the ways in which culturally and linguistically diverse students could gain more thorough understandings of what is typically an unfamiliar enterprise. He concluded that "the highly political nature of public discourse and its connection to student identity presented students with the challenge of balancing their identity with their use of science discourse" (p. 121). Emdin (2008a) provides an

example of confronting such issues in urban science education from a critical and culturally responsive perspective. His approach consists of co-generative dialogue through popular culture, as well as student autobiographies of their learning in which students were able to 'read and write the world' through their own voices, using hip-hop and rap music (Emdin, 2007, 2008a, 2008b; Freire & Macedo, 1987). This research illustrates students as co-creators and co-investigators of scientific knowledge, in that they are re/writing and speaking about scientific information as it applies to their daily lives and cultural backgrounds (Emdin, 2007, 2008a).

Thus able to situate their lived experiences in the world, Emdin (2008a) demonstrates how diverse urban minority students can be empowered not only to achieve at high levels but to reach higher levels of agency as well (Freire, 1970; Lee, 2001). An important aspect of a critical approach to science highlighted by Emdin's (2008a) study is the distinctly political act of using hip-hop to 'own' the language or discourse of science, which has long been viewed as an exclusively Eurocentric domain (Aronowitz, 1988). Moreover, Emdin (2008a) responds to the need identified by Brown (2006), who found scientific discourse to be "a problematic component of science learning" for culturally and linguistically diverse students when attempting to balance their rich, discursive identities with science discourse, which ultimately acted as a gatekeeper to the development of scientific literacy (p. 121). The emancipatory potential of science as a political act also suggests problematizing local (and global) issues of race and ethnicity while covering science content is one possible approach for teaching about diversity.

From this perspective, science can be used in ways that help students develop scientific knowledge by critically and politically engaging issues beyond the high-stakes

regime of accountability in the classroom (Lipman, 2004). This might include community-oriented, critical scientific investigations as that conducted by Buxton (2010), in which diverse urban students examined the differential effects of the quality, distribution, and consumption of natural resources such as fresh water in the poor and affluent areas nearby. Such investigations are facilitated by critical discussions on the instrumental use of science in society to support capitalistic rather than human-centered progress (Barton & McLaren, 2001). In this sense, science education is not merely a political and contestable arena in which to challenge distorted power differences, but also a site of social change by eliminating the barriers and gatekeepers that distance science from students in diverse classrooms (Brown, 2006). Furthermore, adding these critical components provides a channel for a less vacuous multicultural education along with less essentializing forms of antiracism in science and science education.[19] However, in practice, the consistent application of such macrosocial inquiries are often difficult to achieve (Atwater, 2011; May, 1999; McLaren & Torres, 1999).

In the ruins of historical power differentials in society aimed at reproducing the cultural values of the dominant group, these forms of critical (science) pedagogy are characterized as combative and divisive tools of the political Left, or diluted forms of protesting that do little to problematize critical issues facing public school systems (Bowers, 2005, 2008). For instance, due to a supposed tendency toward utopian and positivist-normalizing forms of education, critics such as Bowers (2005) liken the

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[19] Early antiracists adopted a rigid stance that favored a black-white binary view as the principal form critique of racism over cultural pluralism. Thus, having become trapped within a reductive, dichotomous metanarrative of racism that ignored postmodern identities (Hall, 1992) and the intersectionality of race, gender, and class oppressions (Collins, 2000) embedded within educational discourse, a solely antiracist approach to racial inequality would not suffice in a pluralistic society (May, 1999).

ambition of critical pedagogues seeking to transform society with the market-based infusions into social policy promoted by the neoliberal project currently dominating social and economic policies around the globe. Further, Gur-Ze'ev (1998) asserts that "all current versions of critical pedagogy function as part and parcel of normalizing education and its violence" and alternatively suggests that a non-utopian, anti-positivist counter-resistance in science education would not privilege any universal or particular view of society so long as it is non-repressive and democratic (p. 463). Tubbs (2005), on the other hand, offers a rather different critique of critical pedagogy, as well as its postmodern permutations. Tubbs (2005) argues that despite its historical ties to critical theory, critical pedagogy tends to ignore philosophical self-examination, and have therefore lost sight of "the triadic relation of understanding, change, and objectivity" (p. 228).

For Tubbs (2005), by focusing only on material forms of domination that produce false consciousness, or in the postmodern sense, subjective and discursive forms of domination, each attempt to unveil oppression rejects or perhaps ignores the role of abstract consciousness in self-critique (Rømer, 2011). Together, these critiques suggest that applications of critical pedagogy in science may require a more responsive and self-critical approach in order to avoid immobilizing its inherent transformative potential for teaching about diversity. As an outgrowth of critical pedagogy that shares a similar vision social justice, culturally relevant/responsive instruction is embedded with critical and sociopolitical consciousness of plurality that can assist in this move toward raising important issues about science, diversity and education (Ladson-Billings, 1995a; Laughter & Adams, 2012; Mensah, 2011).

Culturally Relevant/Responsive Pedagogy and Science

Culture is an integral aspect of how information is communicated, received, and conceptualized, and therefore an instrumental component human cognition and interactions. Culturally relevant and responsive pedagogy (CRP) suggests that how science is taught to students from diverse ethnoracial, cultural, and linguistic backgrounds is an important aspect of science education. The concept of culturally relevant pedagogy was popularized by Ladson-Billings (1995a, 1995b, 2009) based on her experiences of the exemplary practices of educators who by centering instruction on their cultural identities, were able to promote high levels of minority achievement. These are teachers who understand that when situated within students' "cultural and experiential filters" or lived experiences, subject material and skills are learned easier, more interesting and meaningful, and the resulting content knowledge more durable. In other words, teachers who are culturally responsive understand the "dynamic or synergistic relationship between home/community culture and school culture," (Ladson-Billings, 1995b, p. 467) and use "the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively," (Gay, 2002, p. 106) and to empower them by facilitating a critical consciousness of human agency (Ladson-Billings, 1995a, 1998). Students who are taught in responsive ways, irrespective cultural background or academic discipline, tend to reach high levels of academic achievement (Gay, 2002; Ladson-Billings, 2009).

This position asserts that providing equitable access to education in general requires teachers who are both aware and responsive to the various nuances of culture in diverse classrooms. And further, that to do so they must also understand the value of

inclusion in the classroom, as well as the importance of culture in how information is transmitted and received, which suggests that teachers must first attend to the beliefs and mis/conceptions they may hold about different races, ethnicities, and cultures. And while integrating students' cultures in the classroom can be challenging, O. Lee (2001) and O. Lee and Fradd (1998) contend that teachers with firm scientific knowledge, with respect to their depth of understanding of general science content and specific subject matter, as well as an understanding of language and culture often promote student success in the science classroom as well. In this way, culturally relevant science pedagogy proposes to engage minority youth, as well as the culturally unaware educator, in ways that increase science achievement and critical awareness of social justice issues of race and ethnicity by drawing attention to inequities within the communities where they teach and learn (Atwater et al., 2013; Barton, 2003; Barton & Berchini, 2013). O. Lee (2001) argues that this perspective also begs questions of "what counts as science, what should be taught, how science is taught, and how student learning can be assessed in valid and fair ways"; and further, that "the quality of educational experience suffers if Western science is imposed on students who do not share its system of meanings, symbols, and practices" (p. 499). As alluded by Buxton (2010) and Brown (2006), this ultimately suggests that equity of voice in scientific discourse, science curricula, and critiques of scientific knowledge should also be of particular concern (Aronowitz, 1988; Atwater, 2010).

Together with multicultural science education, which is later discussed in more detail, critical and culturally relevant science pedagogy points to the need to decolonize science curricula, as well as provide entry points for students of diverse cultural backgrounds to learn and perform science (Aikenhead, 1996, 1997; Atwater, 1996b,

2010; Gay, 2002; Hickling-Hudson, 2003; Jegede & Aikenhead, 1999; Nieto & Bode, 2012). This includes developing the critical awareness of how dominant cultural groups have traditionally been privileged in STEM-related curricula "through the selective inclusion and exclusion of material" in various textbooks (Asante, 1991; Kumashiro, 2001, p. 4). Kumashiro (2001, p.4) argues, for example, that "mathematics has been a tool of colonialism and imperialism" to dominate others by using the ability to quantify nature, time, space, and thus society, through an assumed "logic of control" and reason.

As to the subsequent inability of some students to connect to a Europeanized curriculum, Hickling-Hudson (2003) contends that this discourse of colonialism currently embedded in education is "culturally problematic," and "does emotional and intellectual violence" to those who do not assimilate to the westernized hegemonic program (p. 3). Swartz (2005) adds that the:

> dismissal and disregard for decades of scholarly research nestles close to the core meaning of censorship: the restriction of knowledge through a process that discriminates what may even enter the books selected as repositories of 'standard' knowledge by school systems. (p. 32)

The implication is that while science, and more generally, STEM achievement, are indeed important for future sustainability in this country, so too are the ramifications of unexamined science practice on local and global societies, and its effects on privileging specific forms of knowledge while obscuring issues related to the inequitable distribution of resources and indifference of difference among other cultures. Lipman's (2000, 2002, 2004) studies demonstrate how this is especially true in urban schools and communities where *stakes is high*, to use a phrase from hip hop artists De La Soul (1996),

if you please. Not only with respect to oppressive tests that claim to 'count ability' while claiming accountability, but the constant threat of dying at the hands of a killer called in/visibility, stifling mobility, but for the sake and in the interest of political economy—some bullshit, really (Barton & McLaren, 2001; McLaren & Farahmandpur, 2001).

For instance, McLaren & Farahmandpur (2001) point to relationships between the corporate models of education and global economic policies of "advanced capital societies," and argue that decreased government funding has forced an unsettling relationship between public education and private corporations, who seek to capitalize on an $800 billion knowledge industry (pp. 139-140). Despite the aim of producing highly-skilled workers through quality STEM education, under the corporate model of education, information has become the new commodity and is least accessible to the poorest students, many of whom are concentrated urban cities (Barton and McLaren, 2001; McLaren and Farahmandpur, 2001). And since urban cities tend to be centralized in discussions of science, technology, and the global economy, STEM education should include critical views of not only how it can be taught in culturally responsive ways, but also the implications of the access and opportunity delimiting role it often takes in society (Darling-Hammond, 2005; Lipman, 2004; Nembhard, 2005).

Culturally relevant science pedagogy offers powerful alternatives to mainstream science teaching and learning by valuing culture and holding high standards, while re/emphasizing the need for consistent critical inquiry to examine how science is applied (Irvine, 1992; Ladson-Billings, 1995b; Nola & Irzık, 2005). In particular, involves forms of inquiry that examine micro- and macrostructural obstacles to science teaching and learning in a multicultural world and global political economy, as well as the ongoing

critical analysis of human diversity. Doing so would provide a basis from which students could not only acquire scientific skills, but become critical researchers in society. Though, as Mensah (2011) notes, "teaching in culturally relevant and or multicultural ways requires a knowledge base about teaching for cultural diversity as well as understanding the sociopolitical context of multicultural education" (p. 297).

Multicultural Education and Science

Following the *Brown Decision* in 1954 and Civil Rights Movement of the 1960s, concepts of multiculturalism and cultural pluralism became more prevalent in public and educational discourse, and provided a curricular basis for multicultural education (MEd) (Banks, 1993a, 1993b; Banks & Banks, 2010; May, 1999; Sharpe, 2005). And indeed, over the course of its development, MEd came to include more critical and culturally relevant pedagogical approaches; however, an early vision of MEd was to:

> reform the school and other educational institutions so that students from diverse racial, ethnic, and social-class groups...experience educational equality...[and] to give both male and female students an equal chance to experience educational success and mobility. (Banks, 1993a, pp. 3–4)

The underlying hope for this new field was that it would provide a viable means to facilitate increased cultural intersections in society, as well as address issues of achievement disparities among minority students (Atwater, 2011; May, 1999). However, critics of MEd contended that structural effects of racism were understated, and the curriculum, overemphasized (May, 1999). Antiracist criticisms, for example, included the notion that multicultural curricula were naïvely viewed as a panacea for increasing academic achievement and social mobility among minority students (Gill & Levidow,

1987; May, 1999; Swartz, 2005). Among these debates was the view that MEd was but a neatly framed utopian treatment that was privileged at the expense of deeper analyses of power differentials and race relations in society, and that it lacked sufficient analytical depth and sociopolitical scope to adequately confront issues of racial discrimination that pervaded schools and society (May, 1999).

In addition, there was a rather healthy skepticism about whether the dominant class would even allow multicultural education to develop as it was proposed. Afrocentric scholars such as Molefi Asante, who being well-familiar with the history of suppressed knowledge and cultures of non-dominant groups, were rightly concerned with a hidden agenda of white multicultural proponents (Asante, 1991; Asante & Ravitch, 1991; Bernal, 1987; Diop, 1974; Swartz, 2005). Driving this concern was that notion that the multicultural movement would be co-opted and fashioned into a new form of Eurocentric hegemony, as was evident in The Freedman's Bureau's role in the mis/education of blacks in the South during the mid-19th century (Anderson, 1988; Asante & Ravitch, 1991; Woodson, 1933). From this perspective, multicultural education would amount to little more than a near-passive addition to the process of schooling, whose covert purpose would be to reinforce Eurocentric values rather than to critically intervene in the political, racialized debates and educational discourse in society (May, 1999). MEd developed and refined its mission and as the field gained traction, various academic disciplines began incorporating the tenets of MEd into the curriculum. Social studies was among the first domain-specific area to adopt MEd as a curricular disposition, and science, among the last (Atwater, 2011). This inclusion of MEd in

science would be significant for years to come, and increasingly move into the sociopolitical and social justice arenas (Atwater et al., 2013; Hickling-Hudson, 2004).

Throughout the 1990s and the 2000s, multicultural (science) education was increasingly informed by critical and culturally relevant pedagogical approaches. One intention of this infusion was to support a science education for diversity, in which MEd practitioners connected student culture to school culture, and helped galvanize the transformative project of critical pedagogy (Atwater, 1989, 1996b; Atwater & Riley, 1993; Atwater et al., 2013; Hurtado et al., 2008, 2010; Lee, 2011).

Multicultural Science Education

The growing diversity in this country has all but ensured that MEd will remain a pillar of democratic education (Ball, 2006). Owing to more recent national attention regarding underrepresented groups in STEM fields and preparing a scientifically literate workforce, a growing body of literature on science education and student diversity has begun to emerge (Hurtado et al., 2008, 2010; NRC, 2007a, 2007b, 2007c, 2010; Riegle-Crumb et al., 2011; Wang, 2013). Since the late 1980s, MEd has been at the forefront of such efforts to make science more accessible, and has been most thoroughly conceptualized and commonly known as multicultural science education (MSE) (Atwater, 1989, 1996b; Atwater & Riley, 1993; Hodson, 1993).

In accordance with the mission of the American Association for the Advancement of Science (AAAS, 1989) and the national standards for science education outlined by the NRC (1996) which respectively promote “science for all” students and the need for accessible forms of scientific inquiry, MSE applies multicultural education as a postmodern approach to developing equitable ways of learning and teaching science

(Atwater, 1996b). Here, the MSE literature assumes a postmodern stance against metanarratives inasmuch as science is conceptualized as a socially and culturally constructed 'language game' of power, and thus, a contested domain in which the dominance and universalist presumptions of WMS can be interrogated, and the inclusion of autochthonous epistemologies in scientific inquiry insisted upon (Aikenhead, 1996; Aronowitz, 1988; Atwater, 1989; Atwater & Riley, 1993; Carter, Larke, Singleton-Taylor, & Santos, 2003; Hickling-Hudson, 2003; Jegede & Aikenhead, 1999; Lee & Buxton, 2008; Lyotard, 2009).

Atwater (1996b) describes MSE as "a field of inquiry with constructs, methodologies and processes aimed at providing equitable opportunities for all students to learn quality science," and suggests that multicultural science educators believe that:

> (1) all students can learn science, (2) every student is worthwhile to have in the science classrooms, and (3) cultural diversity is appreciated in science classrooms because it enhances rather than detracts from the richness and effectiveness of science learning. (pp. 34-35)

In this regard, MSE scholarship demonstrates salient features aimed at improving science involvement and achievement among minority students. Among them is the mission to decenter the persistent view of science as a monolithic specialty devoid of culture, ethnicity, and gender, and only accessible to certain groups or individuals. Extensive research has been conducted to examine the implications of the fact that science is still primarily taught from a male, Eurocentric epistemological perspective (Aikenhead, 1996, 1997, 1997; Atwater et al., 2013; Carter et al., 2003; Jegede &

Aikenhead, 1999; Suriel & Atwater, 2012). Yet, due to the presumed neutrality of science, such embedded forms of racism are allowed to persist (Gill & Levidow, 1987).

In contrast, MSE takes a social constructivist stance that seeks to give ownership of science learning to the students, while also emphasizing the significance and impact culture has on the learning process (Atwater, 1996b; Au, 1998; Lee, 2008; Sheets, 2005; Ültanir, 2012). To ensure this connection, various aspects of multicultural education are implemented in "science curriculum, science teacher education, student science learning and instruction, science assessment, and science evaluation" (Atwater, 2010, p. 103). However, while multicultural learning activities are engaging and support democratic views of schools society, their implementation in science curricula has indeed proved rather challenging (Atwater, 2010; Banks & Banks, 2010). In addition, Rodiguez (1998) and Rivera Maulucci (2013) note that some PSTs will either directly or indirectly resist applications of critical pedagogy, culturally relevant pedagogy, or multicultural education. From a CPSP perspective, this lack of responsiveness is explained by the disassociation of strategy and implementation from the social and historical conditions that initially stimulated the need for critical discussions of human diversity in education. Without deliberately unpacking complexities of race and ethnicity, the value of these approaches fades behind the moniker of 'feel-good instruction' (Ladson-Billings, 1995a). Thus, in the absence of context regarding how and why race remains a significant point of contention in contemporary society (i.e., that/why racism still exists), there is also a risk of fomenting feelings of resentment among PSTs toward debates about such issues, thereby impeding the development of a critical conscious about race relations.

May (1999) and Nola and Irzık (2005) have argued that this is, in part, a result of the strong focus on curriculum integration that multicultural (science) education seems to conveniently elide critical inquiry in general, and deeper treatments of race and class in particular at the expense of PSTs. Moreover, similar to Asante's (1991) suspicions, McLaren and others have often argued that multicultural applications were little more than a repackaging of neoliberal market ideologies served as pluralism (Kanpol & McLaren, 1995b; McLaren & Torres, 1999). Despite its apparently heavy curricular focus or supposed capitulation to market-based ideologies of late capitalism proposed by McLaren and others, along with critical and culturally relevant insights, multicultural (science) education ultimately seeks to ensure that students of different cultural backgrounds are able to connect to academic content (Atwater, 1996b; McLaren & Torres, 1999). Furthermore, as Swartz (2005) argues, such responsive forms of education do not seek to be another type of centrism, only to put into clearer context the contributions and perspectives of a multicultural world that exists beyond the borders of European history and ideology. Building on the approaches highlighted above, this study will use the multiperspectival lens of CPSP to explore the potential role of science in teaching about diversity and its implications for future practice. The critical and interpretive framework of CPSP inherently challenges status quo assumptions about race by examining it as a socially constructed concept of subjugation within the broader contexts of human history. In doing so, CPSP also *displaces* reified notions of biological determinism and student ability which in turn allows for the collective reconstitution of human diversity as a common narrative of cultural multiplicity, and ultimately, assists in giving voice to silenced and marginalized students in 21st classrooms.

Towards a Critical Postmodern Science Pedagogy of Human Diversity

Given the vast influence of critical and postmodern educational approaches on an expanding array of multicultural and culturally relevant modes of teaching and learning science in a knowledge-based economy, the above suggests numerous implications for CPSP. Along with multicultural and culturally relevant approaches to science, the political focus on equity and social justice embodied by critical pedagogy allow for more substantive applications of MSE. This not only helps situate MSE within the context of the political economy, but by incorporating the responsive nature of CRP and the emancipatory project of critical pedagogy assists in the development of a more transformative agenda for science (McLaren & Torres, 1999). Critical multicultural and culturally responsive forms of science offer the ability to politicize macroscopic issues of class, gender, and socioeconomics, and to challenge revisionist forms of history that either distort or omit the many contributions of non-white cultures (Swartz, 2005). Embodied within these approaches is a respect for the localized, cultural streams of knowledge students bring into the classroom, including preferred discourses of science and identity (Brown, 2006; Emdin, 2008a; Gay, 2002; Ladson-Billings, 1995b).

By expanding the discourse of science into teacher education, CPSP has the potential to enhance TEPs in general, as those who educate PSTs are distinctively positioned to develop critical researchers and stewards of posterity. Critical researchers in this sense refers to teachers as change agents, who seek to empower others as well as interrupt and transform social and political realities through education (Creswell, 2005, 2007). The scientific discourse of CPSP makes use of what we can know about the natural world, while rejecting metanarratives and the imposition of pathological

hierarchies such as racism and c/overt discrimination in order to more aptly pursue if not achieve the goal of a science of self-interrogation (Derrida, 1978, 1982; Lyotard, 1984; Wilber, 2000). Moreover, as it attends to the notion that we indeed generate a form of power through the local structures we inhabit, CPSP may be useful in helping PSTs develop more thorough understandings of issues involving race, ethnicity, and culture (Foucault, 1977, 1980). This study suggests that one possible approach for achieving this goal is the application of science as a critical method for teaching about diversity, wherein scientific knowledge and discourse are used to illuminate the notion that we share a common humanity that began in Africa, but now comprised of irreducible threads of individual existence (Derrida, 1978, 1982; Diop, 1974). By deliberately turning our attention to the premise that we have more in common as humans than we do based on any cultural and phenotypic differences, a different picture of diversity may begin to emerge. Given the paucity of research on this subject, the following section provides a few strategies to help illustrate what this might look like in a teacher education course about diversity; however, the applications of such an approach are not limited to this area.

CPSP Strategies for Teaching Diversity

A critical postmodern science pedagogy of diversity interrogates, interrupts, and perpetually questions. CPSP is, at once, a critical method for deconstructing common discourse about diversity, as well as for reconstituting humanity as having a common narrative viewed through a variety of lenses. However, by no means is this approach envisioned as a panacea for redressing socially and historically embedded forms of discrimination that have become so deeply woven into the fabric of public education in this country, such as the near-exclusive privileging of Eurocentric curricula, in-school

segregation and the academic delimitations of tracking, and the implicit racism of black/white achievement gap rhetoric (Asante, 1991; Green, 1999; Hilliard, 2000; King, 1991; Kumashiro, 2001; Oakes, 2005). Therefore, it is important to note that the goal of CPSP is not to form yet another metanarrative, or to otherwise escape the complexity of such issues, but through problematizing the very trajectory of humanity become an antiracist, political tool that assists in the development of critical researchers and educators for the 21st century.

In this way, CPSP signifies a shift from oversimplified discussions about the context of racial discrimination, evidenced by what is now a more latent disapprobation of non-white students and the subsequently stolid diversity discourse in TEPs, toward more contextualized and critical debates about humanity that, as Geuss (1981) suggests, "makes the subjects in the society aware of their *own* origin" (p. 70, emphasis original). In contrast to the way that multicultural and culturally responsive approaches are generally taught in TEPs, which simply "enlighten the subjects about their own genesis or origin," or "explain to them how they became the subjects they are with the beliefs, attitudes, norms, etc. they have," CPSP seeks to unravel the web of discursive practices of racism in education in order to:

> [show] them under what conditions, in what 'context,' they acquired these beliefs, attitudes, and norms, and how they came to hold their basic world-picture, that is, how they came into being as social subjects. (Geuss, 1981, p. 70)

Yet, CPSP neither implies nor aims to provide an unequivocal rejoinder to endeavors of personal emancipation, as it is more the pursuit of critical reflexivity itself, and accordingly, the questions one is entreated to explore, from which salient insights

about race and ethnicity might be acquired. The true potential of CPSP lies in its ability to support the development of a critical consciousness about such issues with which PSTs might enter diverse classrooms better prepared to understand, reach, and thus effectively teach, each of their students. Moreover, an added benefit of this approach is that, regardless of discipline, it bespeaks the development of a critically-thinking citizenry, thereby enhancing the potential of a democratic society (Mansour & Wegerif, 2013b).

Three strategies are here presented that, if used as a supplements for diversity discussions with PSTs, could problematize the conflation of skin color with achievement and biologically deterministic misunderstandings of race, ethnicity and culture (Gravlee, 2009; Smedley & Smedley, 2005). These strategies incorporate the scientific disciplines of biology, anthropology, genetics, and geography to highlight the notion of a common human origin in Africa, though not to replace one centrism with yet another. Rather, by loosely centralizing humanity in this way through the use of recent scientific knowledge, these strategies become critical tools through which PSTs might better understand their own racial, ethnic, and cultural identities, as an extension of the same African Diaspora. One potential benefit of doing so might include a greater propensity and ability of PSTs to connect to students from backgrounds different than their own. Another potential benefit is that students and teachers with intercultural, indigenous, and hybrid dispositions may well find it easier to situate their identities and epistemologies in contemporary (science) classrooms after such hierarchical-leveling (Carter, 2004; Moosa-Mitha, 2005). Sadly, although these strategies are based on concepts readily found in K-16 science curricula, much of this information is either glossed over, or simply forgotten. In any case, while these concepts do arise in some culturally relevant and multicultural

science education literature (e.g., Atwater, 2010; Laughter & Adams, 2012), there is little evidence to suggest that such an approach has been used across disciplines as a critical method for teaching diversity to PSTs.

DNA ≠ Do Not Ask

One way CPSP can help initiate discussions about diversity is through a significant element of current scientific knowledge that involves the variation of human DNA. As noted in chapter one, the sum of genetic variation between humans exists only within $1/100^{th}$ of a percent (0.01%), which means that we share 99.9% of our DNA sequence. This becomes valuable knowledge when considering how frequently phenotypic differences, such as skin color, are reinforced in society. Likewise, it suggests two important points about science and human diversity. The first, and perhaps, most obvious of these points is that humans have far more similarities than differences. So much of our social life is spent incessantly comparing ourselves one with another, though with the rather simple goal of validation within our human interactions (Blumer, 1969). Thus, to one degree or another, we tend to seek this validation extrinsically. By understanding that the genetic variability between individuals is so slim—something that is often taught in high school and college biology courses—in the context of education, we are encouraged to see that differences such as race are based on social constructions, and are therefore malleable rather than immutable (Foeman, 2009; Omi & Winant, 1994; Pollock, 2006; Smedley & Smedley, 2005; Winant, 2000). This presents opportunities for changing the way we view ourselves in relation to others by understanding that no one 'race' is better or worse than the other, only different—and not by much at that.

The second, interrelated point is perhaps more of an indictment. Given that so much of global economic sustainability of posterity rests on knowledge, application and innovation of science, it would seem prudent to acknowledge the significance of our similarities. The significance of knowing that humans are 99.9% similar presents the somewhat glaring implication that many of the presumed differences between humans are indeed not at all biological, but rather ideologically based on race, and for the purpose of social and cultural dominance. Reinforcing this simple, scientific discovery in an education class has the potential of developing students' critical consciousness about racial formation and stratification in the U.S. (Foeman, 2009; Mukhopadhyay & Henze, 2003; Smedley & Smedley, 2005). Thus, if the reasons and methods for stratifying society on such bases are but a function of social and cultural hubris, then appealing to PST's critical consciousness might reveal a common humanity in which each person, each student, should be valued firstly on the basis of a common African ancestry.

Pangaea

Another way to begin discussions about diversity using CPSP is through a brief re/teaching about the once supercontinent of Pangaea. This simple exercise is aimed at helping students understand (or remember) that approximately 300 million years ago, the continents were connected. While this might at first seem rather innocuous information, the implications of starting a discussion about diversity with such a notion are quite significant. Visualizing the continents as they were prior to breaking apart and shifting (as they continue to do) can provide a basis for discussing the role of geography in determining the genetic variability in humans. This primordial, postmodern world was one without borders, both in the local and in the global sense. This suggests that as

humanity developed, it was through various emergent social and cultural milieus that borders and "ownership" were developed. More specifically, maps and animations of Pangaea demonstrate two important aspects of human diversity. First, it emphasizes the interconnectivity of the world as it exists in nature without human influence. Second, discussing diversity in terms of Pangaea has the potential of positioning difference not as a precondition for discrimination, but of evolutionary survival. Thus, differences in phenotypical features such as skin tone, hair, as well as the shape and size of various body parts are a function of geographic location and human development over time. This information would therefore be helpful not only in providing context for human diversity, but also for the postmodern world of hybridity in which we now live.

Media Resources

There are also several video and text resources that would be informative in such discussions. For example, diversity discussions could begin with videos such as *Race: The Power of an Illusion* produced by PBS, which demonstrates a DNA lab activity that could be used in conjunction with the concepts of the above discussion. One aspect of the lab involves students finding out that there is actually more genetic variability *within* racial groups than there is *between* racial groups. This upends students' misconceptions about human differences that are based simply on appearance, as white students would likely find that their DNA sequence is more comparable to black students than to other white students. According to the American Anthropological Association's "Statement on 'Race'" (AAA, 1998), this is because the majority of genetic variation exists within racial categories:

> With the vast expansion of scientific knowledge in this century, however, it has become clear that human populations are not unambiguous, clearly demarcated, biologically distinct groups. Evidence from the analysis of genetics (e.g., DNA) indicates that most physical variation, about 94%, lies *within* so-called racial groups. Conventional geographic "racial" groupings differ from one another only in about 6% of their genes. This means that there is greater variation within "racial" groups than between them. In neighboring populations there is much overlapping of genes and their phenotypic (physical) expressions. Throughout history whenever different groups have come into contact, they have interbred. The continued sharing of genetic materials has maintained all of humankind as a single species. (original emphasis)[20]

Although it could be argued that given a large enough sample this may be harder to determine, in which case there could be more evidence of similarities within such categories; however, this would not subdue the fact that the human DNA sequence is 99.9% the same. Another invaluable media source is the award-winning book and documentary by Spencer Wells, a leading population geneticist and director of the Genographic Project from National Geographic called, *The Journey of Man: A Genetic Odyssey*. In it Wells travels around the world analyzing DNA of hundreds of thousands of participants in a quest to map the history of human migration (Maltby, 2003; Wells, 2003). Such resources provide much needed context for beginning teachers to understand their own as well as their students' winding, but common path to the present-day.

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[20] See also: "AAPA Statement on Biological Aspects of Race", 1996

The point here is that while these subtleties help explain human differences, which is important for understanding epidemiological trends, the same scientific knowledge can be used to support a more equitable and democratic human community. These are but a few strategies that could be helpful in beginning discussions about diversity issues with PSTs. The aim of such discussions would necessarily focus on the larger implications of the distortions and omissions of (scientific) knowledge that has contributed to as well as taken from the human experience that we all share. By using CPSP, PSTs would not only be more critically informed, but also active in the pursuit of social justice, empowerment, and the equal representation of all individuals regardless of one's backgrounds. And further, they would also be more prepared to engage students in diverse classrooms to help them reach high levels self-efficacy and achievement.

Summary

The goal of this chapter was to explore, through a critical postmodern scientific lens, the possibility of science to deconstruct narratives of race and human difference that have historically undermined racial parity in schools and society. Despite increasing discussions about student diversity in science education research about critical, multicultural, socially just, culturally relevant strategies and curricula, little has been said about the specific use of science, across disciplines, in TEPs (or otherwise) to show the basis of cultural relevance through our common humanity. To address some of these gaps in teacher education research, and to a growing though still limited understanding of multicultural (science) education, this chapter presented critical postmodern science pedagogy, or CPSP, as a critical, transdisciplinary method of teaching about diversity.

History reminds us that change is constant. However, given that education is so deeply woven into the fabric of society, without thorough and ongoing critical investigations of the past, the social construct of race will remain a socially debilitating cultural phenomenon for what will no doubt be a globally interconnected posterity. In a general sense, learning about and using science should move beyond fetishizing, and the false consciousness that follows mindless consumerism, whether in the purchasing ideas or the production of vice and distraction that produce more alienation from oneself. Highly-skilled, but uncritical and historically myopic laborers will ultimately add little value to global society, and even less to themselves.

In this respect, to avoid becoming an essentializing narrative, a CPSP approach should also include critiques of the domain of science itself, executed through the self-interrogation of "scientific statements" and how they perform in society. Furthermore, because the social functions of a cultural group are not biologically intrinsic or fixed, but rather the external manifestations of that particular group during a specific social and historical period, context is also important to critical discussions about race and ethnicity. In all, CPSP suggests that progress is only as valuable as the level of critique in a society—the extent to which the beliefs and actions of an individual or group are examined from within. Using science as a catalyst for teaching about diversity has the potential to unravel many misconceptions about race by systematically addressing fundamental aspects of our shared humanity, as well as evoke critical questions about the social and historical discourse of diversity in education. The next chapter outlines the research methods used to explore CPSP and respond to the research questions.

CHAPTER III: RESEARCH METHOD

This chapter provides a summary of the research method used in this study which draws on the critical postmodern science framework of diversity presented in the previous chapter. First, the study's purpose and guiding questions are reviewed, followed by a brief overview of qualitative research and case study research from a critical postmodern perspective, including the rationale of using this particular design. A description of the research design is also provided, including a detailed explanation of case and participant selection, data collection and data analysis procedures, strategies to ensure quality and trustworthiness, as well as study limitations and ethical considerations. The aim of this study and the research method outlined below was to address the following questions about science, diversity and education:

1) What is the role of science in teaching about diversity to undergraduate preservice teachers (at an urban research university in the Southeastern United States)?
2) How might this approach impact preservice teachers across disciplines in terms of raising greater critical awareness and influencing inclusive classroom practices?

The research questions were informed by the understanding that current demographic shifts among students do not culturally match the teaching force, and a theoretical framework that recognizes the need for a critical, interpretive, and incisive approach to discuss diversity issues such as race and ethnicity (Stake, 1995). Along with

the theoretical framework, the research questions helped shape the chosen unit of analysis through which the phenomenon of the utility of science as a critical method for teaching about diversity to preservice teachers were investigated. To thoroughly examine this potential role of science in what is here referred to as critical postmodern science pedagogy (CPSP), a single case study was conducted with three undergraduate courses designed for preservice teachers that address issues of diversity in education. Multiple forms of data were collected, including field notes derived from classroom observations and demographic questionnaires with open-ended items about science and diversity, as well as in-depth interviews with students and professors. Questionnaires were administered following a researcher- class presentation and discussion. Along with permitting the use of multiple data points to generate rich descriptions, qualitative case study research was chosen for its ability to generate in-depth knowledge that through detailed examinations of 'how' and 'why' science might be useful for teaching about diversity will provide insight on this under-researched topic (Lincoln & Guba, 1985).

Qualitative Research

Qualitative research is a systematic approach to understanding social phenomena through in-depth and detailed analyses of the human experience that can be understood as "a set of interpretive, material practices that make the world visible" (Denzin & Lincoln, 2005, p. 3). As a form of investigative inquiry, qualitative research seeks to understand a social or human problem through thick descriptions of phenomena as they occur in their natural settings (Creswell, 2009). Such investigations often involve a collective interpretation of meaning(s) constructed from the perspectives of both the qualitative researcher as well as participants (Gall, Gall, & Borg, 2005). Given the in-depth nature of

using multiple data sources, an interpretive, qualitative method was used to address the research questions through detailed examinations of participants regarding the utility of science for teaching about diversity (Lincoln & Guba, 1985).

In qualitative research, there is an implication is that theory should be withheld during the investigative process so as to mitigate external influences on the outcome, as if one could approach such a task having no preconceptions (Moustakas, 1994). However, operating under the guise of value-neutrality, much as traditional versions of science is wont to do, it is not infrequent that qualitative research is clumsily burdened by dogged pursuits of unachievable transcendence or phenomenological abstraction (Atwater et al., 2013; Carter et al., 2003). This is not to say that such pursuits have no merit or that they cannot produce meaningful results. Qualitative investigations, such as ethnography, that honor the *emic* perspective of participants' lived experiences, as well as many empirical experiments or examinations, have contributed much to the ways in which we understand the social and natural worlds (Creswell, 2009; Wolcott, 1999).

Role of the Researcher

Qualitative research is unique in its ability to bring the researcher into a study, and with a first-account perspective that provides enhanced understandings of complex social phenomena (Creswell, 2007; Glesne, 2011; Marshall & Rossman, 2006; Patton, 1990). This suggests that the researcher's subjective views and the theoretical positioning are also inextricably embedded within qualitative investigations. As such, attempts should be made to bracket, or systematically account for, such views in the research process, particularly for studies that involve direct interaction with human subjects (Creswell, 2007; Kvale, 2007; Peshkin, 1988; Rubin & Rubin, 2005). Bracketing refers to

the process of removing the researcher's subjectivities while preserving participants' interpretations and experiences with diversity issues in education (Moustakas, 1994). Although we cannot as composite social beings be fully abstracted from the human experience, acknowledging influences linked to the role of the researcher can help mitigate subjectivities brought to the process. Given this inextricable link between researcher and research, in outlining the methodological context of this study on science, diversity and education, the researcher's experiences as an often doubly-marginalized black-white biracial student and educator are important to note.

Prior to becoming a doctoral student, the researcher taught science and technology courses for six years in relatively rural areas of the Southeastern U.S., including one year at the middle school level and five years at the secondary level. As a graduate student, the researcher taught two undergraduate teacher education courses at the proposed research site, which is located in a large urban center. Further, as a result of many real and perceived instances of marginalization and a subsequent desire to affect positive change as a critical actor in education, the apparent prevalence of uncritical dispositions about and preparation for diversity is of particular interest in this study. Owing to personal experiences as both a member and educator of and for diverse groups, the researcher maintains a critical perspective of the ways in which knowledge and power are mediated and views issues in teacher education as being linked to power differentials in society. This, because it is largely through social institutions such as education that the ability to generate self-directed meanings is governed, and whereby the legitimacy of knowledge is most noticeably brokered and deemed either valid or invalid in relation to the dominant group (Altbach, 1971; Apple, 1978; Blake & Masschelein, 2003; Blumer, 1969;

deMarrais & LeCompte, 1998; Gandin, 2011). Thus, as a critical researcher and student/teacher of science and education, it is the researcher's position that there exist both hidden and explicit (social) oppressions functionally mediated through classroom instruction, and that the effects of which continually shape individuals' social and educational experiences. This perspective not only supported the epistemological and theoretical basis of the study, but offered an analytical and interpretive lens capable of piercing the surface of diversity discourse in teacher education during the investigation. The aim was to uncover that which might otherwise reduce PST training to the reproduction dominant cultural values and social hierarchies (Aronowitz & Giroux, 1991; Bourdieu & Passeron, 1990; deMarrais & LeCompte, 1998).

While having a strong familiarity with the issues and impacts of racial discrimination and exclusion in education was important, it also suggests the inexorable influence of bias on the research process. In particular, the present study was likely influenced by the researcher's role as a minority, a science educator, and student/teacher of education, who critically views society as being imbued with oppressive discourses and discriminatory treatment of traditionally marginalized racial and ethnic groups. In addition, prior examinations of literature on science, diversity, and education may have also affected the ways in which diversity issues of race and ethnicity in education were approached throughout the study. In this sense, the collection and ongoing analyses of questionnaire, observation, interview data was likely influenced by the personal and professional experiences of the researcher. However, the continued development of personal and academic understandings of what it means to be relegated to the fringe of society and its effects in the classroom also provided an acute sensitivity for issues

involving cultural mismatches between students and teachers, and importantly, the significance of being prepared to teach in diverse settings.

Moreover, to presume for example, that one could perform any measure of inductive or deductive analysis that would produce, say, a grounded theory or theory of special relativity without having at least an uninflected tenor of bias imposed on the analyses seems a futile argument (Einstein, 1920; Glaser & Strauss, 1967). In other words, while it is important to take into account the effects of external influences during the investigative process and in the analysis of data, to suggest that theory or Self should (or could) be suspended from, rather than made explicit within and iteratively scrutinized for new directions and possible misconceptions, indeed, seems regressive. Thus, despite implications of value-laden views and inherent biases, critical and contextualized appraisals and a reflexive empathy for participants provided a meaningful basis for richer analyses. Furthermore, member-checking and other forms of triangulation helped account for any inherent bias and ensure the study was trustworthy and of high quality.

Criticalist Research This section briefly outlines the epistemological basis for the study, which connects the previously discussed theoretical framework with the criticalist research design alluded to above. Criticalist research assumes socially and historically embedded disparities of power bound to ideologies and discourses that both construct and limit the subjugated individual through multiple and interconnected forms of oppression enacted by institutions, systems, and structures throughout society (Canella, 2007). Similarly, the goal of this research was to develop incisive explanations regarding the unit of analysis that would lend insight beyond surface-level data from observations and participants' responses. This means examining the data as well as human interactions for

latent oppressions and power differentials often subtly muted by social, cultural, or structural influences. Not only would the absence of such awareness work against an interpretive research design, but it would dispel the opportunity to affect positive change in education as it is counterintuitive to the ancillary goal to help prepare PSTs to be critical stewards of posterity (Apple, 2010).

The CPSP framework outlined in the previous chapter ultimately directed this criticalist research paradigm, within which a single case study was used to explore the utility of science as a critical method to teach about diversity in undergraduate teacher education programs. This position contests pathological forms of rationalism, objectivism, and logical positivism on the basis that there exists no singular objective truth and reality, but rather a series of social and cultural derivatives, interactions and institutions that (mis)shape our multiple perceptions of reality in order to situate the human subject within it (Atwater, 1996b; Haraway, 1988; Hartsock, 1989; Hutchison, 2006; Kincheloe, 2005; Lather, 1992; Ültanir, 2012). This suggests that any method of constructing, acquiring, sorting, analyzing, or transmitting knowledge is not a passive activity, and that social institutions necessarily influence and often attempt to direct social activity (Kincheloe, 2005; von Glasersfeld, 1984). Thus, from a CPSP perspective, within the irreducible plurality of contextual, often overlapping conceptual schemas re/constructed and shared among preservice teachers about race and ethnicity rests many ‘truths’ and social realities that are perhaps more aptly understood as co-mediated inter/actions between the subject and the world, as well as the oppressions enacted by and/or upon them (Bernstein, 1983, p. 8; Freire, 1970; Kincheloe, 2005).

An important implication posited by a CPSP framework is that research, instruction and the production of knowledge are irrevocably intertwined in respective struggles against dominant class social and cultural reproduction in education, as well as the instruments, grand narratives and ideological dimensions of power by which they are governed (Apple, 2000; Aronowitz & Giroux, 1991; Bourdieu & Passeron, 1990; Foucault, 1980, 2002; Freire, 1970; Kincheloe, 2005; Lyotard, 1984). As previously discussed, misapplications and wrongful positioning of scientific knowledge have traditionally privileged males of direct European descent, which often led to social distortion and stratification especially along the lines of race, gender and sexuality (Campbell, Denes, & Morrison, 2000; Collins, 1998; Foeman, 2009; Larson, 1995; Marks, 2008; Ordover, 2003; Witzig, 1996). This critical perspective suggests that the systematic process of scientific inquiry does not occur mutually exclusive of external factors. In contrast, when viewed as one of many social narratives, critical applications of scientific knowledge can help explain various causal links in the natural world, including the history and trajectory of humanity (AAAS, 2010; Aronowitz, 1988; Diop, 1974). However, much of the research that addresses diversity issues in teacher education does little to deconstruct social and historical elements of race and culture, particularly through a scientific lens. Guided by a CPSP framework, this case study sought to address some of these conceptual gaps, and thus, to contribute both practical and theoretical knowledge about the utility of science in grounding teacher practice in more critical and inclusive understandings of student diversity.

This task was accomplished through the use of descriptive and explanatory narratives derived from field notes, observations, interviews and class discussions with

three undergraduate teacher education courses. This approach allowed collective meaning(s) to be re/constructed in ways that respond to the role of science as a critical method for teaching about diversity and that inform the practice of PSTs as they prepare to enter diverse classrooms. Investigating the commonality among all humans with PSTs evoked critical questions and responses during the interviews and class discussions about social and political influences that have shaped history and continually shape the present. As suggested in the previous chapter, a CPSP perspective implies that such reflections would include critiques of the domain of science itself with respect to power and political economy, or the many injudicious uses of science that have historically undermined democratic race relations (Barton & McLaren, 2001; Marks, 1996; Smedley & Smedley, 2005). Furthermore, the propensity in U.S. society to either ignore, obscure, or reify issues of racism and other such hierarchical discriminations due to largely unexamined structural forces of the past suggests that examining the disproportionate effects of power within the context of science, education, and diversity is a pivotal component in PSTs' development of critical and robust understandings of race and ethnicity. Given the current lack of discourse and educational research in this regard, this study's findings suggest that the phenomenon of using science to teach about, deconstruct and discuss such issues from a critical postmodern perspective is a potentially viable option for achieving this goal, and in supporting human responsive, highly effective educators for the 21st century.

Broadly speaking, preservice teachers' social and cultural influences prior to pursuing a career in education offer important contextual clues about how and what views were formed about race and ethnicity, as well as their preparedness to teach in diverse classrooms (Garmon, 2004, 2005). Just as science has traditionally been subjected

to whims of power exercised through dominant social institutions and cultural milieus, preservice teachers' views about race and ethnicity, either directly or indirectly, respond to the confluence of socially and historically contingent forces. Yet, in the social apertures formed by confronting scientific knowledge and teacher education as contested sites of knowledge production for pedagogical practice, context-specific realities are then re/formed, re/fashioned, and expanded relative to PSTs' particular worldviews and provide insight for preparing PSTs to teach in diverse settings.

Much in the way that multicultural science education endeavors to reconstitute misconceptions about the natural world by generating new scientific knowledge that incorporates the myriad cultural influences brought into the classroom, the impetus for this study was to offer new ways of initiating discussions about diversity in teacher education programs from a scientific perspective (Atwater, 1996b). To this end, the study sought to reconstruct participants' understanding of the social world, while also acknowledging social and historical contingencies that influence the production of knowledge (Denzin & Lincoln, 2005; Guba & Lincoln, 1994). The epistemological grounding of the study and its alignment with the theoretical framework allowed for a critical, interpretive exploration and description of meanings co- and re-constructed throughout the investigation from the perspective of both researcher and participants.

It is important to note that this study sought neither to constrain nor to reduce what is known about teacher education and human diversity down to strict generalizable principles, as positivist or purely universalist conceptualizations of science might otherwise be inclined (Loving, 1997; Matthews, 2008). Rather, it sought to explore the utility of science as a critical method to expand the ways in which complex features of

knowledge production about diversity are discussed and confronted within the context of a multiply-constructed, culturally nuanced narrative of humanity (Kincheloe, 2005). A central goal of the study was to demonstrate that by using science to assist in developing a more critical consciousness in teacher education about race and ethnicity, it is possible to co-construct new perspectives of what it means to teach in diverse settings in ways that are more democratic and inclusive. Through a CPSP lens, the present research suggests contextualized discussions, interactions and collaboration with PST participants while also attends to larger social and historical influences that negatively impact their views about diversity, and subsequently, their classroom practices in diverse settings (Garmon, 2004; Howard, 2006; Sleeter, 2001). That is, valuing participants' individual perspectives and descriptions encouraged critical reflections that provide deep and meaningful insights into their views of science, diversity, and education (Baxter & Jack, 2008; Lather, 1992). Therefore, it was the intention of this research to contribute knowledge toward the positive transformation of teacher practice through a critical awareness and reflexivity about race and ethnicity afforded by critical applications of science in TEPs. Indeed, the contextual adaptability and depth of perspective afforded by an interpretive case study design presented such an opportunity (Stake, 1995, 2005; Yin, 2003).

Case Study Research

Case study research is a form of empirical qualitative inquiry used to address questions of complex social phenomena within a bounded system (Creswell, 1998; Yin, 2003). Framed within the particular time, space and place in which they occur, case studies contribute to knowledge of individual, group, organizational, social, and political issues through multifaceted investigations of phenomena within authentic (naturalistic)

contexts (Baxter & Jack, 2008; Miles & Huberman, 1994; Rowley, 2002, p. 16; Yin, 2003). Regarding their scope, Yin (2003) notes that case studies make deliberate use of these contextual conditions for their salience in understanding the phenomenon of the study and role in defining the often unclear boundaries between them. This, he argues, is because the "phenomenon and context are not always distinguishable in real-life situations," which necessitates in-depth investigations as a means to delineate between them (Yin, 2003, p. 13). As such, case study research is useful for exploring questions that seek to describe, explain, or evaluate an intervention, such as the understudied phenomenon of CPSP in the present study, as well as the context of the case and the site where the investigation occured (Hartley, 2004; Yin, 2003).

Dobson (1999) offers that when conducting an interpretive case study, one should first state whether a descriptive or an explanatory approach is being used, where "description suggests the adoption of an idealist philosophy whilst explanation suggests a realist approach" (p. 268). However, as Luck et al. (2006) suggest, the dynamic scope of case studies points to the dialectical interplay of structure and agency in interpretive educational research, which Broadfoot (2002, p. 5) contends is extant "between the external directives to institutions which shape the social space and the individual's capacity to choose; to be self-determining." One implication is that in-depth case studies are those in which the macro/collectivist perspective of structure and the micro/individualist perspective of agency are both taken into account during the research process (Archer, 1995; Bandura, 2000). By this measure, the critical postmodern perspective used in this study suggests that both description and explanation were necessary. On one hand, there is a need to explain macrostructural effects regarding the

TEP itself, such as curriculum and supervised experiences. Yet, with respect to an equally vital need to respond to the individual agency and worldviews of PSTs, providing contextualized descriptions of these structural conditions would be more informative than structural explanations alone (Dobson, 1999; Kilduff & Mehra, 1997).

In order to capture issues (i.e., conflicts/alignments) of structure and agency with regard to PSTs, TEPs, diversity and the understudied phenomenon of CPSP explored in this study, descriptive as well as explanatory elements of case study research were addressed. Whereas descriptive questions address the "what" of social phenomena, explanatory questions might examine the "how" or "why" of these phenomena (Boeije, 2010, p. 25). The case for the present study was framed within the context of one TEP in the college of education at an urban research university in the Southeastern United States. This context defined the boundaries of the phenomenon under investigation – the role of science as a critical method for teaching about diversity. The unit of analysis through which this phenomenon was explored consisted of three PST education courses that address social issues in education such as student diversity. An additional point of inquiry was considering how the use of science to illuminate issues of race and ethnicity might assist in preparing PSTs to teach in diverse classroom settings. In all, the study was interested in the efficacy of science in teaching about diversity in TEPs, and how doing so would inform and promote more positive and inclusive teacher practices.

Furthermore, earlier discussed was the notion that while it cannot directly answer questions of a personal or cultural nature, science can provide likely causal relationships from which to draw conclusions about ethical issues (AAAS, 2010). In this sense, both the descriptive and explanatory components of this exploratory case study assisted in

linking the collected data with participants' perceptions about using science as a critical method to discuss diversity issues. The central research question is descriptive to the extent that it can be answered with rich interpretations about the role of science in teaching about diversity, and exploratory in that it also proposes further inquiry along these lines (Yin, 2003). The secondary question is explanatory to the extent that the study seeks to explain how and why using science to teach about diversity would be beneficial to preservice teachers in particular, as well as teacher education programs in general. The context and participants therefore served as a means to describe and explain the phenomenon of using science to discuss diversity issues in teacher education, and thus to contribute knowledge about moving 21st century teacher education toward positive, transformative and inclusive teacher practices.

Case Study Design

Case studies are ideal for exploring unique or understudied phenomena (Hartley, 2004; Yin, 2003). Case study design is directed by the research questions and related theoretical perspectives, as well as the overall purpose of the investigation (Baxter & Jack, 2008; Yin, 2012). The research questions and purpose of this study were not exclusively concerned with the case of PST courses, but rather the phenomenon of CPSP in the preservice teacher classroom illustrated by the case. As such, the focus of the inquiry extended further than the case itself given that using science as a critical method to teach about diversity is neither indefinitely bound to the context, nor the unit of analysis. The case study design chosen to explore this topic was influenced by this need to examine and understand a phenomenon beyond the case.

This aligns with Stake's (1995) view that case studies can also be used as an instrument to understand phenomena beyond the case. Like most case studies, an instrumental case study explores a particular case within a bounded context to gain a better understanding of some phenomenon; though, rather than studying the case itself, the researcher is primarily interested in particular phenomena that can be accessed through the case under investigation (Stake, 2005). This study was interested in the phenomenon of science as a critical method to teach about diversity, or CPSP. An instrumental case study design allowed the researcher to focus on and gain insights about this specific external interest through a particular case (Luck et al., 2006). With this approach it was not necessary to find a typical case by which to examine CPSP, but rather, one that might assist in providing insight into a related issue. Thus, while important for the implications CPSP may hold for TEPs in general, the case of three PST courses became secondary to the issue being examined and served as support rather than the focus (Stake, 2005). As a proxy to access the investigated phenomenon of CPSP, the unit of analysis supported an instrumental case study design.

Research Design

An effective research design involves creating a plan for establishing a logical connection between the research questions and the methods used to investigate and acquire supporting evidence from which to later draw conclusions (Yin, 2003). Such a plan for how a research study is conducted generally includes explicating the procedures for the collection, analysis and interpretation of data. According to Yin (2003), an effective case study design is comprised of five components: a) the study's questions; b) its propositions (if any); c) its unit of analysis; d) data-to-proposition linking logic; and e)

criteria for interpreting findings. Each of the following components are discussed in turn, below (p. 21). Using an in-depth, single case design this study explored the role of using science to teach about diversity to preservice teachers and how doing so might inform their practice in positive and inclusive ways. The study was conducted in four phases (Appendix G) with three undergraduate teacher education courses that address student diversity. Details of the research site, sampling strategy, and phases of data collection and data analysis are provided in the following sections.

Research Setting

To more closely examine the central phenomenon of science as a critical method for teaching about diversity, this case study was delimited to the College of Education at Tesaw University (TU), an urban research university located in Kemetville (KMT), a large metropolitan area in the Southeastern United States. The university is located in a diverse city and is surrounded by many diverse urban communities. Many of the courses required for admission into the TEP and for teacher licensure address various aspects of student diversity, including race, class, gender, linguistics and ability within the context of the 21st century classroom. Likewise, reflection, instrumentation and context are also important aspects of case study research (Stake, 2005).

In each of the courses, interactions between the researcher, students, and professors, as well as classroom discussions related to issues of race and ethnicity were critically and reflexively examined using instruments and methods designed to explore the larger issue pertaining to the efficacy of CPSP for addressing diversity issues in teacher education (Baxter & Jack, 2008). These instruments of inquiry included questionnaires, participant observations, interviews and researcher-led class discussions.

Each of these instruments provided valuable data with which to explore the central phenomenon of this study. Along with critical yet responsive observations, interactions and discussions, by narrowing the focus of the investigation to a single case comprised of multiple data sources and overlapping aspects to the PST unit of analysis, the study was situated to yield thick, contextualized descriptions of the utility of CPSP in preparing teachers for diverse classroom settings (Baxter & Jack, 2008; Yin, 2003).

Context is another important aspect of qualitative research, and qualitative case studies in particular. Case study contexts or backgrounds may include the social, historical, cultural, political, economic, ethical, aesthetic and physical (Stake, 2005, p. 449). Several contextual features supported the selection of the TU College of Education as the primary research site in this study, including: the number of teachers produced in the state by TU, the student populations they are likely to encounter, and the demographic trends of PSTs in the TEP at TU. With respect to the study's focus on the role of science in teaching about diversity issues in teacher education, the sampling frame of PST courses was relevant to understanding this phenomenon for several reasons.

First, despite the evident ability of science to improve quality of life and the growing emphasis on producing a scientifically literate workforce, little is known about the utility of science for teaching about diversity. Second, as previously discussed, the distinct demographic homogeneity among U.S. teachers (i.e., predominately white females), coupled with the general lack of critical and contextual examinations of race and ethnicity in many TEPs, threatens the achievement in a rising number of classrooms with students from diverse cultural backgrounds (Howard, 2006; King, 1991; Milner,

2006; Swartz, 2003).[21] This apparent lack of critical self-examination in teacher education generally stems from and reinforces an all but imperceptible, internalized sense of privilege espoused by traditionally dominant white culture (King, 1991; McIntosh, 1989). The disproportionate number of cultural mismatches between students and teachers in diverse settings often comes at the expense of the agency, empowerment, and achievement of minority students. Given the expansion of science in society, along with growing classroom diversity and documented incongruity of U.S. teachers and students, one is compelled to wonder to what extent it might help mitigate issues of difference and facilitate teaching and learning in diverse settings.

As was alluded in the first chapter, education in contemporary society necessitates responsive educators grounded in critical thinking and rich, value-added democratic practices that honor diversity and social justice in the interest of all learners. The TU College of Education is nationally lauded for its high-quality TEP and progressive conceptual framework of professional, content and pedagogical knowledge; demonstrated effectiveness through praxis and cultural competence; and strong commitment to making positive impacts in the classroom and the community. All of which suggests that by the end of their college careers, TU teacher graduates will be well-rounded practitioners. Thus, courses were also selected because one or more are required either to be admitted into or to obtain licensure from this TEP accredited by the National Council for Accreditation of Teacher Education (NCATE).

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[21] Yet, pejorative misconceptions about the ability of students from racial and ethnic backgrounds different than their own continue to go largely unexamined in teacher education programs (Cochran-Smith & Zeichner, 2009; Howard, 2006).

According to a recent letter from the president of the accrediting body sent to the institution, the "accreditation decision indicates that the unit and its programs meet rigorous standards set forth by the professional education community" (Cibulka, 2014). The accreditation serves as form of insurance that the university's TEP has met rigorous national standards, as verified by an independent review by educational professionals, policymakers, and public stakeholders. TU assures that NCATE candidates are thoroughly assessed during their tenure and graduates from the TEP are well-prepared and thus highly sought after in job market. In addition to being nationally accredited at both the initial teacher preparation and advanced preparation levels, TU is in a state that leads the nation in National Board Certified Teachers (NBCT) and the institution itself is a leading provider of teachers to public school districts throughout the state (State Education Data). Being located in a diverse urban city, many of the local schools to which PSTs are assigned for field experiences or student-teaching, and districts in which many will likely begin their teaching careers, are racially and ethnically diverse urban schools. Along with the abovementioned commendations, this suggests a quality teacher education program that produces graduates who have the potential to generate a significant positive impact on minority students across the state.

Yet, when juxtaposed with rising classroom diversity, the fact that the overwhelming majority of U.S. teachers are white females who often find it difficult to connect with non-white students appears to belie this potentially positive impact (Brown, 2007; Delpit, 2006; Howard, 2006; King, 1991; Milner, 2006). Interestingly, this national trend of teacher demographics is reflected among current PSTs at TU. The percentage of white teachers across the nation is approximately 82.7 percent; 76 percent of whom are

female (National Center for Education Statistics, 2013c). Recent TU institutional data report a total enrollment of 26,571 students, roughly 3.43 percent (992 students) of which is accounted for by undergraduates in the College of Education. Data from the 2013-2014 school year show that 82.85 percent of PSTs at TU are white (812) and that 76.31 percent are female (757). In line with this trend, approximately 82.3 percent of 2013 teacher graduates were white, and roughly 72.43% were female (TU Institutional Research data). The implication is that Tesaw's PSTs and teacher education graduates may also find it difficult to connect with students from cultural backgrounds different than their own. This point is particularly applicable given that while these PSTs (during field experiences) and new teacher graduates (at new jobs) primarily serve diverse student populations, they may espouse similarly uncritical assumptions about minority students' academic ability or willingness to learn (Delpit, 2006; King, 1991; Kunjufu, 2002).

The majority of these misconceptions are based on predisposed views of race and ethnicity formed prior to—and implicitly reinforced through—their TEPs, as such issues tend not to be discussed from a critical perspective (King, 1991; Sleeter, 2001; Swartz, 2003). By contrast, when combined with critical self-appraisals consistently high-quality instruction, a teacher's ability connect with students from a variety of cultural backgrounds not only supports democratic principles of self-efficacy and agency, but can have demonstrable effects in the way of high academic achievement in high needs areas such as science (Chenoweth, 2007, 2008; Gay, 2002; Ladson-Billings, 1995a, 2009; Lee, 2011; Lee & Buxton, 2008). Rather than engender a strong and inclusive multiplier effect through the profession, however, the literature suggests that TU teacher graduates may

instead hinder achievement, particularly in the state's more diverse school districts (Howard, 2006; King, 1991; Sleeter, 2001; Suriel & Atwater, 2012; Swartz, 2003).

The complexity of these issues suggested that a case study of PSTs at Tesaw University would produce valuable information about the potential role of science for teaching about race and ethnicity in TEPs, and also illuminate points of entry for CPSP beyond the case. Stake (2005) notes that instrumental case studies "draw the researcher toward illustrating how the concerns of researchers and theorists are manifest in the case" (p. 450). As such, this contextualization not only served to position this case study, but by addressing a gap in the research and a critical need in education, reinforced its potential to contribute to an important knowledge base aimed at developing strategies to prepare PSTs for diverse settings. The follow section details the purposive sampling strategy used to select the particular case, including the criteria for selecting participants.

Case Selection

Yin (2012) defines a case, or unit of analysis, as a bounded entity, such as "a person, organization, behavioral condition, event or other social phenomenon" (p. 6). Binding a case to a specific time, place, activity or context centralizes the phenomenon under study, thereby limiting its scope and ultimately allowing for a more thorough investigation (Baxter & Jack, 2008). Given the essential role of boundaries in defining the case and determining what was studied, delimiting the study to explicit spatial and temporal dimensions was important for conducting a detailed investigation (Stake, 1995; Yin, 2003). The spatial context of the case consisted of three diversity-related courses designed for undergraduate PSTs in a single TEP at an urban research university. Temporally, the unit of analysis was bounded to the timeframe allotted for classroom

observations, participant interviews and class discussions, which took place from November 2014 through January 2015 (Appendix G).

Furthermore, a key component of a qualitative sampling strategy is the extent to which it contributes to understanding the central phenomenon being investigated and responding to the research questions (Creswell, 2012). Of particular interest in this study was exploring the phenomenon of the potential role of science in teaching about diversity in the case of PST education courses. This sampling frame as well as the individual courses and participants that constitute the case in this study were purposefully selected on the basis of demographic and contextual representativeness, and overall relevance in developing an in-depth understanding of this phenomenon in the context of teacher education (Patton, 1990; Stake, 2005). By investigating the phenomenon of CPSP using multiple courses and participants but combined as a single case, the hope was that it would allow for thick descriptions of the potential role of science in reconstituting diversity discourse through critical reflection on the social and historical contexts of race and ethnicity (Baxter & Jack, 2008).

The role of CPSP was explored at the primary research site (TU's TEP) with PSTs and professors in three undergraduate courses that address foundational issues in education aimed at establishing a baseline for their careers as professional educators. In order to bind the case and to assist with managing data collection and analysis processes, courses and participants included a convenience sample from a purposefully selected group of courses in the TU College of Education (Patton, 1990; Stake, 2005). A review of descriptions of undergraduate teacher education courses pointed to nine potential course candidates, from which three were chosen (Appendix H). Sampling criteria required that

the courses were: a) designed for undergraduate preservice teachers; b) required either for admission into the TEP or for licensure; c) emphasized social and foundational issues in education such as student diversity and teaching in diverse settings.

The convenience sampling strategy was used to select the three different courses and participants consisted of solicitations and informed consent which included the purpose of the study, the research questions directing the study, as well as a brief explanation of the procedures that were used (Appendix A). Initial recruitment letters were sent via email to instructors of the different courses requesting: a) to observe their class; b) that they complete an online questionnaire, which included the informed consent notice (Appendix C); c) that the researcher be allowed to conduct at least one class session; d) to conduct an follow-up interview – included on the questionnaire, and d) that they disseminate the questionnaire link to students. To ensure that the background of the study and the informed consent request were not overlooked, this information was also provided in the first section of the online questionnaire (Appendix C). To participate in the study, students had to meet specific criteria: a) they had to be a student at TU, and enrolled in one of the courses selected by the researcher, and in which the instructor agreed to participate; and b) they had to be at least 18 years old. This section outlined case selection context and criteria. The following section details the data collection process that used to explore the notion of CPSP in teacher education.

Data Collection

Creswell (2012) outlines five interrelated steps in the qualitative data collection process, which include: 1) identifying participants, research site, and sampling strategy; 2) obtaining permission to access the site and possible participants; 3) determining which

data types are most salient for answering the research question; 4) designing protocols for data collection and recording; 5) and collecting data, with particular attention on ethical considerations (p. 205). Previously discussed were strategies used to identify the research site, the sampling frame for the PST courses, criteria for selecting study participants, and the method for soliciting and obtaining informed consent. This included explaining the contextual relevance of collecting data at the selected site and from this particular cohort of participants. This section discusses data collection procedures and rationale. These procedures were aimed at gathering rich case study data to respond to the research questions and central phenomenon of science as a critical method for teaching diversity in TEPs (Hancock & Algozzine, 2006).

To elicit rich descriptions that would assist in addressing this phenomenon, data were derived from multiple sources of evidence, including: participant and non-participant observations; an online questionnaire that captured participants' demographic information as well as brief narratives about diversity; a researcher-led class discussion that incorporated CPSP; and a semi-structured follow-up interview (Patton, 1990; Yin, 2003). Using multiple data sources to investigate an understudied phenomenon was a particular strength of case study research (Yin, 2003). Collected data included the researcher's field notes, audio recordings and transcripts, and participant questionnaire responses which were triangulated to increase the overall quality and reliability of the study (Yin, 2003). Triangulation of multiple sources of evidence helped ensure that collected data was accurate and aligned with the thrust of the inquiry through multiple measures of the same phenomenon (Yin, 2003, p. 99). In this case, field notes from

observations were cross-referenced with questionnaires and transcribed interview data to determine the extent of convergence among participants' responses.

Questionnaires

After receiving confirmation from instructors who agreed to participate in the study, data collection commenced with classroom observations and a 10-20 minute online questionnaire. As mentioned, the questionnaire was designed to capture demographic data as well as assess participants' views regarding diversity-related issues such as race and ethnicity, and the potential role of science in discussing and teaching about them (Appendix C). Questionnaire responses also aided data triangulation with interview transcripts and field notes. In addition, the initial section of the questionnaires included background information about the study and an informed consent notice. The final section helped set up interview dates and times for those who agreed to one. The questionnaire was open-administered—meaning that participants will complete them outside of class on their own time—during the period in which classroom observations were conducted. For those who agreed to be interviewed, questionnaire data were compared to interview responses to gauge any changes in participants' dispositions about science and diversity in teacher education. Responses were also used to triangulate observation and interview data. The researcher took all necessary precautions to ensure confidentiality of the questionnaire data, by saving it on a secure web application platform accessed through a university account.

Observations

Questionnaires were completed within the first two to three weeks of the data collection process, during which time participant observations were also conducted.

Observations took place in the TU College of Education. Each selected course was observed 2-4 times during their scheduled meeting times. Given that the purpose of this study was to explore the role of science for teaching about diversity, the focus of the observations was conceptualizing how and why this strategy might be important for PSTs for teaching in diverse settings, and what a sustained approach to doing so might look like. That is, what are the current perceptions of these PSTs about race and ethnicity, and how might infusing a critical scientific approach prove relevant for enhancing positive and inclusive teacher practices? Classes were observed from November 2014 to January 2015. Researcher reflections continued along this line of inquiry as questionnaire responses were submitted and the interviews began.

Interviews

Participating students and instructors were interviewed in person, by phone and electronically via Skype, and lasted an average of approximately 50 minutes. In-person interviews were conducted on campus, although a majority of the interviews were conducted either by phone or Skype. Participant responses were transcribed and personal identifiers were either changed or removed to maintain their anonymity. The semi-structured interview format assisted in gaining a deeper understanding of how participants view the role of science as a cross-curricular practice for teaching about diversity. This format also allowed more flexibility with interview protocol, in that it could borrow from questionnaire and observation data, as well as other interviews.

Instructional Intervention

At the discretion of each professor, the researcher led a class discussion using CPSP initially guided by the lesson plan in Appendix F. Each researcher-led session took

place in the classroom of the respective course sections for a maximum duration of approximately 150 minutes per class. This was contingent on the instructors' course flexibility and the length of scheduled class meetings for the each section. The researcher discussed beforehand with instructors their preferences for the class presentation and discussion so that it might blend into the current structure and pace of each course.

Throughout the data collection process, it was important to bear in mind that questions regarding race and ethnicity are sometimes sensitive in nature, and that students might be reluctant to discuss such topics either in class or in the interviews. Thus, as part of the informed consent letter (Appendix B), participants were assured full confidentiality and were notified of the option to review any transcribed data.[22] In addition, the researcher took pains to be responsive when addressing sensitive topics, while still adhering to the goal of in-depth data analyses that respond the study's research questions.

Data Analysis

As earlier suggested, the primary strength of the data collection strategy was its multiplicity of methods. By drawing from multiple data measures to understand the singular phenomenon of CPSP in teacher education, this case study provided a basis for rigor and quality on an understudied topic. This laid the groundwork for rich analyses of the findings, and thus a greater understanding of the potential utility of this approach to diversity education purpose and driving inquiry of this study.

In qualitative research, the iterative process of data analysis begins at the onset of the study (Dey, 1993; Sandelowski, 1995; Stake, 1995). This includes general perceptions by the researcher regarding thematic connections that emerge during

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[22] It was anticipated that the timeframe will help as they will likely be more comfortable by mid-semester.

observations and interactions with participants. Such analyses, for Stake (1995), are "a matter of giving meaning to first impressions as well as to final compilations" (p. 71). During observations, for example, these first impressions stemmed from questions such as: a) *What's going on in this situation, or that situation?* b) *What does that behavior, phrase, body language, gesture mean?* and c) *What symbols are used to illustrate meaning, and what are they?* (DeWalt & DeWalt, 2011; Spradley, 1980). In general, data were examined using Miles and Huberman's (1994) and Braun and Clark's (2006) data analysis procedures similarly consisting of reduction, display, and conclusion drawing.

The initial open-coding process incorporated constant comparative analysis to simplify and focus the data from questionnaire responses, observation field notes, and interview transcripts into manageable segments and categories. Constant comparative analysis is helpful for reducing data through the iterative process of coding and recoding (Glaser & Strauss, 1967). Although the constant comparative method is generally associated with the inductive development of grounded theories, its use is not restricted to such designs (Glaser & Strauss, 1967; O'Connor, Netting, & Thomas, 2008). The implication being the constant comparative method may have applications in naturalistic inquiry beyond the production of theory as a way of maintaining an emic perspective during qualitative investigations in order to allow for more in-depth analyses, for instance (Fram, 2013). Data analysis also included Spradley's (1980) semantic relationships of inclusion and attribution, in which coded data were arranged, using Microsoft Excel (MSExcel), according into segmented categories that corresponded with topics related to science and human diversity and in the context of teacher education (i.e., segment X is a

[form of] Y). In this way, throughout the study, questionnaire responses, interview recordings and field notes were also coded and analyzed.

Data Analysis Procedures

To summarize and conceptualize collected data, Miles and Huberman's (1994) data analysis procedures of reduction, display, and conclusion drawing were implemented. This involved anticipated findings and experiences relative to data collection, as well as how they were managed and interpreted afterward (DeWalt & DeWalt, 2011). Atlas.ti and MSExcel software were used for the coding and analysis which involved data organization and textual analyses, as well as generating and organizing themes and topics relative to the research questions and purpose of this study. All data were securely stored in digital format on a password protected computer. The following steps explain how an understanding of the observed phenomena were developed during this phase of the study.

Reduction

Among the initial steps in the analysis process was data reduction, which generally involves simplifying and focusing data in order to make it more manageable (Miles & Huberman, 1994). This included, for example, elaborating on general and specific aspects of an experience and searching for commonalities and patterns in the data by making memos about recurring segments/categories and linking related quotations. The related processes of frequency and declaration or enumeration (of quotes/phrases) was also used to detect specific patterns in the data (LeCompte, 2000). As part of the reduction process, data were analyzed from a CPSP perspective using constant comparative coding method which began with open and axial coding of observation and

interview transcripts (Strauss, 1990; Strauss & Corbin, 1990). During the open coding process, data were 'chunked,' or divided, into several broad categories using related to science as well as issues of race and ethnicity in teacher education (Glaser, 1978). Next, axial coding was applied, which is "a set of procedures whereby data are put back together in new ways after open coding, by making connections between categories" (Strauss & Corbin, 1990, p. 96). Data chunks and codes were iteratively compared throughout this process, from which code segments were then formed into core categories, and the remaining categories into themes (Glaser, 1978; Glaser & Strauss, 1967; Spradley, 1980).

A preliminary step to this purposeful management of data involved a textual analysis of documentation searching for frequently occurring words, as well as in-context quotes and descriptions of situations. This produced a list of descriptive terms and phrases that were then indexed into categories developed from field notes, transcriptions, and reflections on these data from a critical postmodern science perspective (DeWalt & DeWalt, 2011). The goal was to develop a list of codes and definitions that could also be used as cover terms for particular domains, with respect to science, diversity and education (Spradley, 1980). Next, using Spradley's (1980) semantic relationships of inclusion and attribution, data were re/arranged within and between code segments and categories, in addition to being checked against field notes and transcripts to ensure accuracy, and then re/coded against the indexed categories. For instance, where *code segment* **X** *is a type of* **Y** *relationship*, "**X**" might be a recurring phrase among PSTs or researcher observation regarding discussions of race and ethnicity in the classroom and/or when using CPSP; whereas "**Y**" might refer to an interconnecting conceptual or

emotional response, such as an ‘identity reference’ or ‘ambivalence toward issues of race.’ Resulting categories were grouped into taxonomic categories based on contextual relevance to the research questions as well as the frequency of their occurrence (LeCompte, 2000). These categories assisted in the formation of patterns/themes to help provide insights for understanding the potential role of science in the preparation of PSTs for diverse settings.

Displaying the Data

The process of reduction continued into the second step, where data were re/coded and displayed using Atlas.ti, MSExcel and CMapTools to create semantic concept maps and tables. Doing so assisted in identifying patterns/themes through both visual and numerical representations (Daley, 2004; LeCompte, 2000). Visual displays of data were used throughout the research process, from initial conceptualization to data organization and analysis, which helped make deep conceptual connections beyond the text (Daley, 2004; Miles & Huberman, 1994). In this particular case, patterns were identified among categories that emerged from the coded segments, and those, from the raw data (Strauss & Corbin, 1990). Categories were then ‘collapsed’ into larger components and re/arranged into preliminary themes related to the central phenomenon in this study of CPSP. Resulting taxonomies of semantic relationships were then illustrated as a concept map, table, or other such visual representation. The result of the coding and analysis process was the identification of themes that illuminate the potential role of CPSP in deconstructing diversity discourse in teacher education, and to offer in its place a reconstituted vision of human diversity grounded in critical, compassionate and inclusive teaching practices.

Drawing Conclusions and Verification

Not only did visual displays help reduce and organize data, but they were also instrumental for interpretation and drawing conclusions throughout the analysis process (DeWalt & DeWalt, 2011; Miles & Huberman, 1994). Interpretations of the study findings were derived from these various analyses, which were ongoing and primarily involved comparing participant data/responses to explore the role and impact of using science to teach about diversity. Findings and concluding analyses were written during the spring 2015 semester.

As the previous sections allude, the process of drawing and verifying conclusions in this study included numerical data. However, it is not wholly uncommon in qualitative research, and particularly case study designs, to incorporate various quantitative methods (Yin, 2003). While it is understood that numbers are merely representative and hold neither intrinsic nor existential meaning, not only did the supplementary enumeration make the data more manageable, but it also helped reveal unforeseen patterns that could verified against qualitatively obtained data. As Miles and Huberman (1994) note, "qualitative analysis of all data with the aid of numbers is a good way of testing for possible bias, and seeing how robust our insights are" (p. 254). This in turn helped offset inherent biases in the research process thereby increasing the trustworthiness of the study.

Trustworthiness

Yin (2003) offers that "the development of case study designs needs to maximize four conditions related to design quality: (a) construct validity, (b) internal validity (for explanatory or causal case studies only), (c) external validity, and (d) reliability" (p. 19). To increase validity of the findings and to strengthen the overall credibility of the study,

data were triangulated using observation notes, interviews, participant responses and narratives, and member checking (Creswell & Miller, 2000; Seale, 1999; Stake, 2010). In addition, as the interview protocols were semi-structured, they allowed for questions to be derived from field notes and questionnaires. This provided opportunities for consulting the data to see if it aligned with participant responses.

In all, the researcher strove to reflectively consider the intended audience as well as questions of purpose, voice, and interpretation across field notes, interview transcriptions, and narratives (Creswell, 2012; Polkinghorne, 2003). Further, participants had the opportunity to discuss concluding analyses before being made available to the school, community, or for publication. The aim of which was to help ensure that, as human subjects, participants and their views remained central in this investigation while providing conceptual space for in-depth data analyses that responded to the research purpose and questions regarding the role of science in teaching about diversity.

Ethical Considerations

When conducting qualitative research with human subjects ethical considerations should be the highest priority (Yin, 2003). As the "primary vehicle for emic inquiry," this is especially true in case studies as they often involve sustained interactions with participants (Lincoln & Guba, 1985, p. 359). As such, the anonymity and confidentiality of participant data were a primary concern in this study. In addition, as earlier mentioned, it was important to consider that issues of race and ethnicity may be sensitive area of discussion for some participants. Therefore, being responsive to this reality was also a goal throughout the study. Overall, this study imposed no perceivable risks to

participants, nor did it pose any harm, although it may offer several benefits to teacher education programs and classroom instruction, particularly those in diverse settings.

At the outset of the study, participants were asked to provide informed consent, which was acquired prior to beginning the online questionnaire. Hard copy versions of the informed consent agreements were also available as an alternative to the online form (Appendix B; Appendix C). Participants could print the agreement from the online questionnaire. Information about the risks, benefits, and study design were detailed on this form. Participants were also provided with the researcher's contact information for any additional questions they might have had about the study. Only participants who were at least 18 years old were allowed to participate in the study; thus, parental consent was not required. In addition, they were free to withdraw from the study at any time.

With respect to data collection procedures, several precautions were taken to preserve participants' anonymity and confidentiality. For instance, the online form was located on a secure (remote) server using an account registered with Tesaw University, which meant that participants had to use their institutional login information to access the web application. Upon logging in to complete the form, participants' email addresses were captured to verify their affiliation with TU, which was required to complete the questionnaire. This also served as a means to create a unique identifier during data collection to keep participant information linked; however, at the time of data analysis, participants' email addresses and other identification were de-identified. Questionnaire responses were accessed through the university's secure network and saved on a spreadsheet in a university provided Google Drive account, visible only to the researcher via a password protected computer.

Furthermore, prior to all interviews, verbal consent was requested as interviews were audio recorded. Audio files and transcribed interviews were kept on a password protected computer that was only be accessed by the researcher. After being transcribed, audio recordings were deleted. Participants were also notified of the option to view transcriptions. To preserve participant anonymity, email addresses and pseudonyms were used in the data analysis and write-up rather than their real names. After questionnaires and interviews were completed and responses from both instruments matched, email addresses were deleted and replaced with the randomly generated number. Hard copies of any collected data will be destroyed after three years by shredding. Data collected from participants may be used for professional development and publication purposes; however, participants will be made aware of the potential use of the anonymized data for future research. After six years, all electronic files will be deleted.

Potential Benefits

CPSP promotes developing a critical social consciousness about issues of race, ethnicity and culture as they pertain to education. Thus, while the study posed no risk or harm to participants, there are many potential benefits of using science to teach about diversity in TEPs. The primary benefit of this research, both to participants and to society, is raising awareness about diversity issues in ways that promote positive and inclusive teacher practices. PSTs would directly benefit from such understandings, as it would in turn enhance their ability to reach students from diverse backgrounds. Similarly, this research offers a powerful additive to PST educators in the TEP at Tesaw University in preparing teachers to be successful in diverse classroom settings.

Benefits to society include the ability of more informed teachers and teacher educators to prepare a diverse and critically informed workforce and citizenry, which ultimately supports the cultivation of a democratic society. Used as a critical method in teacher education, science has the ability to increase preservice teachers' awareness and understanding of critical aspects of race and ethnicity underlying the more prevalent discourse surrounding diversity. It is anticipated that doing so will inform their practice in positive and inclusive ways that strengthen student-teacher relations and promote high academic performance in diverse settings, across subject areas. Ancillary benefits of this study include promoting critical-thinking, scientific literacy, and collaboration among within and between classrooms and schools. Such benefits inherently support the nation's goal of growing a critical and pluralistic citizenry able to meet the challenges of a knowledge-based society centered on math and science skills.

Summary

Chapter three provided a summary of the research method used in this study, which draws on the critical postmodern science framework of diversity earlier presented. The research purpose and guiding questions for this study were reviewed, followed by a brief overview of qualitative research and case study research from a critical postmodern perspective, which included the rationale of using this particular design. Also provided was a description of the research design and procedures, including a detailed explanation of case and participant selection, data collection and data analysis procedures, strategies to ensure quality and trustworthiness, as well as study limitations, ethical considerations and potential benefits of this research. The primary focus of this study and the use of case study design was to address the research questions.

In doing so, the chapter illustrated how these questions were informed by an understanding of the implications of uncritical cultural mismatches between students and teachers, and a multiperspectival framework that recognizes the need for a critical, interpretive, and incisive approach to discussing diversity issues such as race and ethnicity (Kincheloe & Berry, 2004; Stake, 1995). Also discussed was the link between the theoretical framework, the research questions, and how through the chosen unit of analysis the phenomenon of the utility of science as a critical method for teaching about diversity to PSTs was investigated. By outlining and connecting the research design to this line of inquiry, this chapter provided the basis for an in-depth, qualitative case study that explores the role of CPSP (Yin, 2003). The next chapter will discuss relevant findings, followed by a fifth chapter that synthesizes these findings, with respect to the overall purpose and research questions guiding that guided the study.

CHAPTER IV: FINDINGS

Chapter one discussed interrelated issues of science and diversity within the larger context of 21st century schools and society, providing a basis for the present study. The primary issue this study sought to address was the need for effective teacher teachers in diverse settings in to support a 21st century workforce. Also provided in the introductory chapter was the purpose of the study, the research questions guiding the study, major terms used, the study's significance, as well as its delimitations and limitations.

Chapter two explored through a critical postmodern lens the potential of science to deconstruct hegemonic narratives of race and human difference that have historically undermined racial parity in schools and society. In addition, chapter two presented critical postmodern science pedagogy (CPSP) as a critical, transdisciplinary method of teaching about diversity.

Chapter three outlined the research method used in this study. The research purpose and questions for the study were reviewed, followed by an overview of qualitative research and case study research, including the rationale for the selected approach. A description of the research design and procedures were also provided, as well as study limitations and ethical considerations.

Chapter four presents the findings from ten (10) semi-structured interviews conducted with undergraduate PSTs and two (2) instructors from three different diversity courses in the TEP at Tesaw University (TU), as well as questionnaire responses and

observation notes. Drawing from the CPS(P) framework, chapter five will analyze and discuss the findings and connect them to the following research questions:

1) What is the role of science in teaching about diversity to undergraduate preservice teachers (at an urban research university in the Southeastern United States)?

2) How might this approach impact preservice teachers across disciplines in terms of raising greater critical awareness and influencing inclusive classroom practices?

The present chapter is divided into two main sections. It begins with the context for the unit of analysis, which includes participant descriptions and relevant information. The second section discusses salient themes that emerged from analyses of the data. Four major themes emerged during the data analysis process. The major themes were: Critical Challenges and Sociocultural Dissonance; "Big Picture" Understandings of Race, Ethnicity, and Culture; Racial Anxiety and Apprehension versus Meaningful Dialogue; Applications, Strategies, and Impacts. Figure 1 illustrates the semantic relationships between participant narratives and major themes (green/rectangular). The findings suggest that science has the potential to contribute to education in meaningful ways.

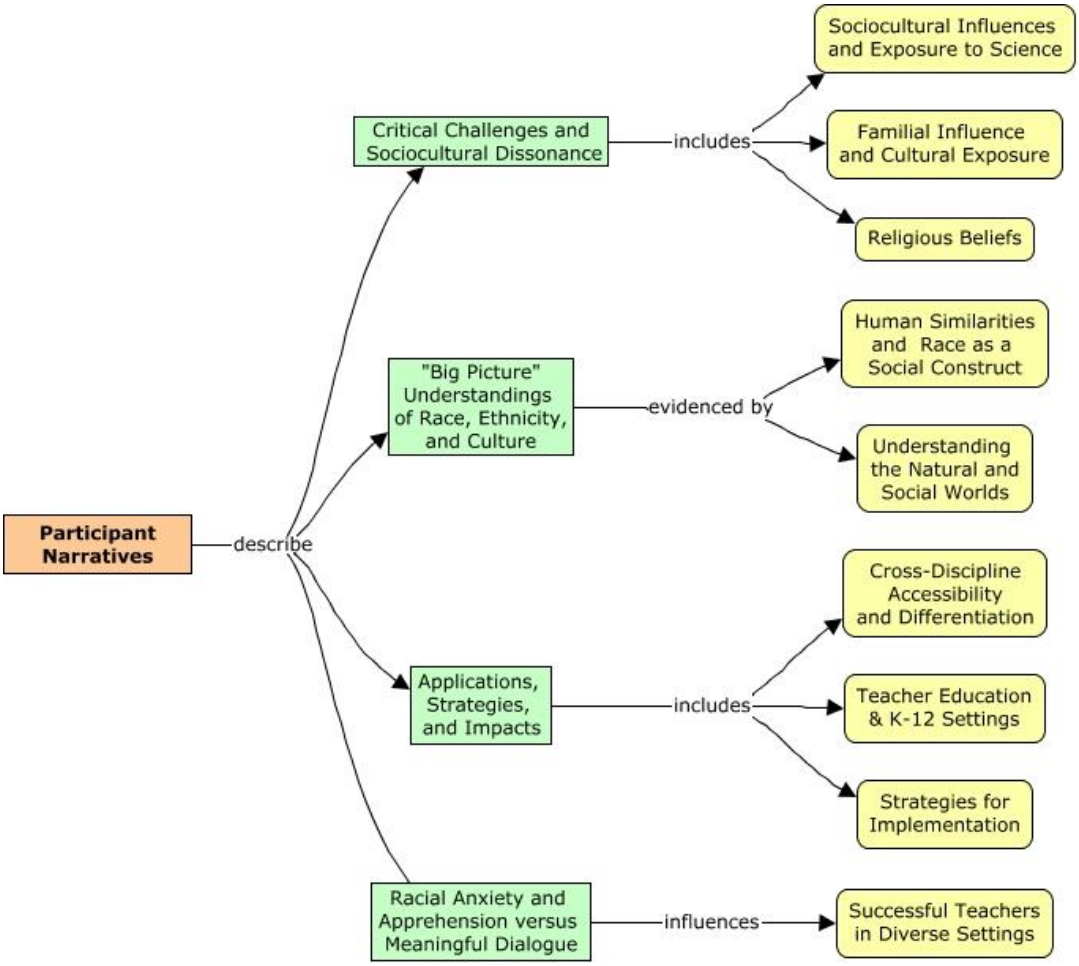

Figure 1. Semantic Concept Map of Major Themes and Subthemes

Context and Unit of Analysis

As stated in the previous chapter, the research setting for this study was an urban research university located in a diverse metropolitan area in the Southeastern United States. The unit analysis in this study consisted of ten (10) students and two (2) instructors from three diversity-related courses designed for undergraduate PSTs. The findings report analyses of questionnaire and interview data gathered from these twelve participants following a researcher-led class discussion regarding human diversity that used CPSP strategies. Table 2 provides a profile of each of the student participants,

including their respective course sections. For anonymity, participants were given pseudonyms.

Student Descriptions

Sheryl

Sheryl is a mother of two from Selma, Alabama. She transferred to TU and is now a junior pursuing a degree in mathematics with an education minor. Sheryl comes from a strong, family-oriented background, and describes herself as a very outgoing person who enjoys helping others. She and her mother moved a lot when she was younger and she attended various schools in the process.

Jackie

Jackie is from a small town in southwest Ohio. She's a sophomore who transferred to TU to pursue a degree in Spanish. She is very adamant about the positive role of education in one's life and discussed some of the perceived issues that impede this potential. Despite having little exposure to diverse settings growing up or in her college classes, Jackie expresses an eagerness to support students to help them be the best that they can be, regardless of their background.

Amanda

Amanda is a junior majoring in English. She grew up in a small town in North Carolina which she describes as very religious. Amanda experienced little in the way of diversity growing up and describes her cultural background as a "modern American family." Amanda prefers to work with older students, and her goal is to become a college professor.

Table 1: Student participant profiles

	Demographics					School Data		Preferred Teaching		Diversity				
Name	Age	Sex	Race	F/R Lunch	HS Locale	Year	Course Section	Locale	Level	Langs. Spoken	HS Pop.	HS Staff	Home Comm.	TU Racial Groups
Sheryl	30+	F	B	Yes	R	JR	A	NP	HS	One	Yes	Yes	No	Many
Jackie	20	F	W	Yes	R	SO	A	R	HS	Two	No	No	No	Prim. one
Amanda	21	F	W	No	R	JR	A	NP	HE	One	No	No	No	Many
Mark	25	M	W	No	S	JR	B	NP	HS	One	No	No	No	Many
Brooke	18	F	W	No	S	FY	B	R	HS	One	No	No	No	Many
Kathryn	19	F	W	No	R	FY	B	U	HS	One	Yes	Yes	Yes	Many
Sophia	19	F	L/H	Yes	S	SO	B	U	MS	Two	Yes	No	Yes	Many
Anna	22	F	W	Yes	S	JR	C	S	HS/HE	Two	No	No	Yes	Many
Angela	30+	F	W	No	S	JR	C	NP	HS	One	Yes	Yes	No	Many
Marilyn	30+	F	W	No	S	JR	C	S	MS/HS	One	Yes	Somewhat	Yes	Two+

Mark

Mark is a junior majoring in history, who lived in Texas and Pennsylvania before moving to a city just outside of Kemetville (KMT). He describes his background as 'bland, middle-class Anglo-Saxon.' Mark is passionate about education and expresses a strong desire to be a history teacher that not only discusses the past, but one concerned with reaching all students and helping them investigate and unpack historical 'truths.'

Brooke

Brooke is a first year student majoring in history. She grew up in a small town in near KMT which she describes as "not very diverse." She attended predominately white schools, and describes her family and surroundings as "people the same race and ethnicity and background" as herself.

Kathryn

Kathryn is a first year student majoring in English, who grew up in a small town not far from KMT and attended Christian schools with little diversity through Grade 8. This lack of exposure to diversity changed when she started high school. And although the shift to a setting with more cultural variety was initially a shock, it seemed to be an overall positive experience.

Sophia

Sophia is a sophomore majoring in Spanish. She is originally from Puerto Rico, but moved to the United States when she was nine years old. Her experiences in with diversity in Puerto Rico were directed in large part by a lack of exposure and her Catholic upbringing.

Anna

Anna is a junior majoring in Chemistry. She was born in Ukraine, but spent most of her life in Florida "in a very traditional Russian home." Many of her early insights and experiences with diversity were influenced by a strong presence of Russian culture at home, as well as the magnet schools she attended in Florida. It wasn't until going to college that she was exposed to greater diversity.

Angela

Angela is a mother and a co-owner of a business with her husband. She decided to go back to school because she always wanted to teacher and is now a junior majoring in English. Angela was "raised by two extremely Christian parents" and describes her upbringing as "very sheltered." She conveyed that her initial views of human diversity were shaped by her parents, who she describes as "narrow-minded" about such issues. She also indicted that increased cultural exposure over time was ultimately more influential on her current views of diversity.

Marilyn

Marilyn is a junior majoring in French. She was raised in California and then lived in the Washington D.C. area for 20 years before moving to a city outside of KMT seven years ago. Marilyn's views on diversity were informed by her experiences with members of Latino/a, Asian, and gay communities while living in California. She describes her views about diversity as being firstly influenced by stereotypes learned from her family, but eventually shifting after personal experiences.

Instructor Descriptions

Jeremiah

Instructor Jeremiah is an associate professor at TU, who specializes in science education. He is originally from Ghana, West Africa, but has been living in the United States for approximately 25 years. Jeremiah is a molecular biologist, by trade, and has been involved in education in various capacities for approximately 45 years.

Teresa

Instructor Teresa is an adjunct education faculty member at TU. She was born and raised in Ohio and has been and educator for more than 20 years. Teresa has a master's degree in Curriculum and Instruction and has taught at every grade level, from K-12 to higher education. She is also certified in several subjects areas, including: reading, middle grades English and mathematics and elementary education, and holds several other educational certifications.

Thematic Findings

This section presents the findings of the study. Four major themes emerged from the analysis of 12 participant interviews regarding the utility of science in teaching about diversity, or critical postmodern science pedagogy (CPSP). Again, major themes that emerged from the analysis were: Critical Challenges and Sociocultural Dissonance; "Big Picture" Understandings of Race, Ethnicity, and Culture; Racial Anxiety and Apprehension versus Meaningful Dialogue; Applications, Strategies, and Impacts.

These themes were interpreted as coming from both participants' and the researcher's perspectives regarding the role of science in teaching about diversity and the potential

impact of this approach in raising critical awareness among PSTs and influencing positive and inclusive classroom practices (Patton, 1990; Rossman & Rallis, 2003).

Critical Challenges and Sociocultural Dissonance

This major theme sets the tone for the remainder of the findings. It emerged from participant narratives that describe critical challenges to understanding human diversity resulting from sociocultural dissonance, or difficulty reconciling unexpected or unexplained (or unexamined) cultural transitions, and potential effect on PSTs (Macdonald, 1998). When brought into the classroom, the negative effects of which often come at the expense of nonwhite students (Howard, 2006; King, 1991; Swartz, 2003). These potentially inhibiting factors include: familial influences and cultural exposure, sociocultural influences and exposure to science, and religious beliefs.

Familial Influence and Cultural Exposure

Given the study's focus on science, diversity and education, understanding the role of science in participants' lives was an important aspect of data analysis. When asked to describe their cultural background and the influence it may have had on their views human diversity, participants offered a variety of responses. Some of which indicated that familial influence and cultural exposure were the most dominant factors.

Sophia describes how moving from a small, Puerto Rican town with little diversity to a large city in the United States was very isolating for her:

> I mean, coming from a small town and moving here, my world was very strict. I guess just closed off to different views. Growing up, I wasn't aware there were religions other than Catholicism, for example. I just - I didn't know. I was very ignorant to just how different everybody could be and then moving here and being exposed to things, but still being so secluded from everybody just for the language barrier and like getting used to how different the culture was.

Despite growing up in a diverse setting, Marilyn explains that her views of race and ethnicity were largely influenced by family members and cultural exposure:

> The community where I grew up, Orange County, pretty much developed as people who were fleeing the increasing diversity in Los Angeles. You've heard the term white flight. So, Orange County was like a white flight place. Then, California was becoming more and more diverse. So, where I grew up, my high school, I wrote [on the questionnaire] that it was a pretty diverse place, because there were tons of Latinos and tons of Asians. Like, all different walks of life, but not very many African-Americans – but tons of other types of diversity…Oh, and the gays, actually. We had tons and tons of gay people.
>
> Everybody was economically pretty much the same actually, but there were not very many African-American people, because - I think because of the original white flight thing. We were very close to Compton. In fact, my grandparents owned an apartment building in Compton. I grew up thinking that I didn't have any racial bias against African-American people until I moved to D.C., and I realized that I had a fear when I saw African-American people. I recognized it. It took me a while to recognize it, but I didn't realize I had it until I spent time with African-American people. Then I had to be like, "Okay, you're being stupid. This is ridiculous." There was an African-American family across the street from us. They were college professors at Cal. State Long Beach. They had more education than my whole family combined. I had to think that through, and then I was, "Okay, you're being ridiculous." This was a time of Marion Barry in D.C. and the whole crack pipe stuff. Initially, it was scary. Anyway, that's where I came from.
>
> AA: What provoked that fear? Have you investigated that further?
>
> Marilyn: I just felt like it was healthy to have a fear if you are in a dangerous situation, but it wasn't related to a person's skin color. It was more like, "You probably shouldn't be in Alexandria at 11 o'clock at night getting gas all by yourself. You should probably be in a better neighborhood that's well lit." I think it was from the news and just hearing about gangs and stuff on the news all the time. I didn't really realize - then, actually - I'm sure my parents were racists, but I just didn't know it growing up because we didn't have any black people in our neighborhood. When we were in California for funeral three years ago, everybody was just talking really racist. My daughter was with me, and we were like "Whoa!" People were saying things like, "I work with this one black woman, and she always helps the black families first, and I can tell she's always nicer to them." These were things that I just wouldn't have anticipated, and I realized at the time that I must have been raised with all of it. Oh, my gosh! I just remembered something, actually. I actually did find - my mom sent me a packet that had all my papers from when I was a kid. I had written a paper. I'm embarrassed to admit this...

> I was a second grader, who really wasn't aware that there were such racists. I wrote this paper. I was in the gifted and talented classes, and we had this writing prompt. I remember it, actually. The writing prompt was "Which is quicker? Black or yellow?" That was the writing prompt. You just write whatever.
>
> You don't have to really use your imagination to answer that. I can't even believe I'm saying this out loud, but I wrote "Which is quicker to ruin a neighborhood?"
>
> AA: In second grade?
>
> Marilyn: My daughter is laughing at me. Yes. I just remember at the time going back when I read this paper five or six years ago, I'm like, "Oh, my gosh!" My grandparents had owned that apartment building in Compton, and then they started building public housing in Compton. My grandparents sold their building because of what was happening. They must have been talking about what was happening to that neighborhood and stuff and blaming it on black people. I was picking up on that, but I wrote an essay about the black people ruining the neighborhood in Compton, and Chinese people - as a second-grader, I was identifying Chinese people as yellow people. Like, "They seem to be fine, upstanding citizens." I don't know. I don't remember the exact text.
>
> AA: That's interesting. It also speaks to the fact that it is something we absorb, knowingly or not, from our environment. Sounds like an example of that.
>
> Marilyn: It's a perfect example of that. Yeah, we have that, and we don't realize that we have that until you're called out on it – this fear based on ignorance. I got over it once I named it when I moved to D.C.
>
> Marilyn adds that she's been rather surprised at the amount of racism still

lingering in the South, and the assumption that, because she was also white, she would

agree with racial epithets and slurs uttered by whites from the South.

> Truth be told, I never heard anybody say the "N-word" out loud until I moved to [this state]. People just dropped it in the conversation. I literally cannot even say that word out loud. I can't even believe - It took me off guard. Then, about two years ago, my kids and I - and my husband – we just said, "We're not going to tolerate it. When people say really horrible things, we are going to say, 'It's horrible, and I don't agree with you.' Try not to make a huge scene. Try not to get beat up, but also say "That's just unacceptable. I don't agree with you just because I'm white."
>
> Anyway, it's been a real eye-opener living in the South. People don't think that - when we go back to DC and tell people the things that people say, and they're like "It's not like that anymore." I'm like, "This happened last week."

Like Marilyn, Angela's states that familial influences and then increased cultural exposure were most influential in shaping her views of human diversity:

> Angela: There are actually two things. Growing up, it was my parents. Their views were very narrow-minded, in my opinion. Once I got into probably about middle school or high school and I started making friends with people that were not like me, that really started shaping my attitude toward [diversity] more just because I got to know people that have different backgrounds that were Spanish, black, white. It didn't matter. I guess the more people that I met since I've gotten older has really shaped my views.
>
> AA: How did that work when you were meeting people that were different from you? Did you have a predisposition about them?
>
> Angela: Yeah, I did. I took a lot of what my parents said and used that as judgment toward people until I got to know them. I was doing football training when I started high school, so I got to know a lot of the guys that played football. The majority of them were black. We hung out a lot, and they ended up being one of the main groups of people that would take up for me because I was really small in school, so I got made fun of a lot. They always had my back. After that, I got really close to a lot of them.

Angela's experiences suggest that increased cultural exposure could have a similarly positive effect of decreasing prejudice and bias for other PSTs.

Mark offers a divergent but related account of how his earlier views of diversity have changed, offers another explanation:

> Mark: My parents' parents were very upper-middle class. My parents were just very middle-class. Even though we were middle-class, there was this air of refinement and, you know - "be proud of what you are." So, very bland, Anglo-Saxon kind of cultural surroundings.
>
> AA: What has been most influential in shaping your views of human diversity, and more generally, people different than you?
>
> Mark: To be honest, I actually got into that kind of stuff through politics. Which happened in about middle school… In high school, I was introduced to various kinds of texts and things. Anarchism is kind of how I got into radical politics, and from there it naturally led to a lot of reading by socialists and things like that. Yeah, I was kind of introduced to the idea of race and stuff like that through radical politics.

> AA: So, how were you informed by your readings and your interactions in that area?
>
> Mark: To put it bluntly, I had a very, I guess you'd say, liberal understanding of race. Where it was like, I thought I was very conscious of it, but I didn't really think about it that much. You know, the whole colorblind attitude.
>
> AA: Do you feel that learning about diversity from a scientific perspective stands in contrast to learning from the more liberal, colorblind perspective of diversity?
>
> Mark: Oh, yeah. To me, the difference is with the colorblind attitude, it's really ignoring the problem. Whereas, from a scientific standpoint it's understanding issues. So I think it's a totally different approach to it.

Research suggests that Mark's earlier views of race which included the so-called 'colorblind attitude,' or as presented earlier, what King (1991) refers to as "dysconscious racism," is indicative of a pervasive, yet false sense of understanding of human diversity to which many teachers subscribe. In an attempt to foster a sense of equality by disregarding racial differences, the colorblind individual makes no such distinctions. While seemingly good-intentioned, ignoring race also elides social disparities that often disproportionately affect racial and ethnic minorities, and can therefore produce a similar effect as deliberate discrimination (Choi, 2008; King, 1991).

Sheryl's familial influences and cultural exposure were somewhat different. She attributes her perceptions of diversity to rich family interactions, her extroverted personality, and her experiences while attending multiple schools:

> Sheryl: My cultural background is very family-oriented. I come from a big family and we would always get together for some reason or another. It was always a close-knit family. And even though we had tons of issues when we got together, we all still had fun together. We still did things as a family, even though half the time we couldn't stand each other. Sometimes you wanted to say, "I'm never coming back!" and then, the next event, we were all back there again.
>
> AA: Do you think that may have contributed to your outlook, both on your own schooling and what you intend to do when you teach?

> Sheryl: Yeah, I think it had a lot to do with it, even though there weren't a lot of new people added to my family until I got older, it was still - it's like my family kind of puts you through a 'trial' when you first come around them. They are their worst when new people come around. It's like they're testing them. They want to see, "Can you really handle this family?"
>
> And as you show them that you're okay - you can handle them being a little bit crazy, it's like you were always there; you're included in everything. And my friends, when they did come around my family, they were like, "I love your family. They're so great." And I'm looking at them like, "Are you crazy?! Have you seen these people?!" But it works for them, and even though I didn't realize I was doing it at first, I was doing the exact same thing.
>
> AA: What has been most influential in shaping your views of human diversity?
>
> Sheryl: I think it's because all the schools I went to, they were always diverse...It was never the same majority at every school.
>
> AA: And was that elementary, middle, or high school?
>
> Sheryl: It was all three, because I moved around a lot.
>
> I'm a really open person, so everywhere I moved I always had different types of friends. It was always fun to learn about them. I had one friend, who was from France. She was the reason I wanted to learn French, because at her house, they only spoke French. And she would teach me words, so that I would be able to know what they would talk about.

Aside from her personality, Sheryl's experiences contrast with those of her classmates in terms of hers and her family's acceptance of others. However, like her peers, her experiences speak to the notion that increased levels of cultural exposure can have a positive influence on how we perceive individuals from diverse backgrounds.

Instructor Teresa connects the importance of education to cultural exposure:

> I think education is really important, and I think with more education, the more you can recognize and relate to human diversity.

For Instructor Teresa, lifelong learners are more favorably disposed toward human diversity due to the desire to understand more about the world around us.

These narratives suggest that while teachers' negative perceptions of diversity and students from a different race, culture or ethnicity (REC) than their own can be influence by family, they also suggest that cultural exposure as well as the determination to see the world differently can help redress the cultural dissonance created by these influences. However, analyses of the data indicated that sociocultural influences and exposure to science also played a role in understanding REC, as well as scientific thinking.

Sociocultural Influences and Exposure to Science

The narratives contributing to this emerging theme implicate one's sociocultural background and experiences (i.e., schools, communities, and religious beliefs) as factors that could potentially influence their willingness to use science to address human diversity. Some participants indicated that sociocultural beliefs and/or lack of exposure to science and diversity may also influence teachers' understanding and receptiveness toward racial and ethnic differences as well as scientific thinking.

Extending the notion of cultural exposure in the previous theme, Kathryn explains how her sense of cultural awareness was impacted by her schooling and community:

> In terms of diversity, I guess in [my hometown] there's not as much diversity. At my high school, they really put a lot of importance on diversity in school, and I think that's why I really loved that high school. When you walk into the common area, they have a flag from every country that every previous student has been to. I think they have a flag from every country in the world.
>
> Even the difference moving from the Christian school and moving to the public school. The Christian school teachers don't really - they don't really teach you anything about diversity, but there's not many diverse students in the school. But that was something that I really enjoyed with learning about - all the different cultures and everything - when I went to public school.

Amanda and Brooke describe somewhat similar sociocultural influences:

> Amanda: Probably, where I grew up. Yeah and most of my family they're just kind of the same, but where I live it's not very culturally diverse. It's pretty much the same thing with everyone.
>
> It's a predominantly white area. There's not a lot – and it's very Christian. Very, very Christian. Obviously, there was a few other religions, but it was predominantly Methodist and Catholic. That definitely, I think, affected my views on everything. I didn't really ever venture much outside of [my hometown]. And then most of my family is from Florida, and it's kind of the same where they're from so it just kind of carried over into [this state].
>
> Brooke: Not very diverse. I mean, pretty much I've been around the same people my whole life, I guess...people the same race and ethnicity and background as myself.
>
> I mean, I've never had hard feelings toward any other culture or background. Even growing up in a small town and going to school [where] there's like five people of a different race than myself, I've never seen anybody treating those people badly. They never seemed like they felt that they didn't fit in. But that's obviously from an outside point of view. I don't really know how they would feel.
>
> Anna adds:
>
> When I was growing up, I was very sheltered. Pretty much, I did not experience so much with diversity. Meaning, I went to school, but when I came home – there was a life in school then, when I was at home, I was strictly only attending everything Russian. I did not have many friends. What affected me the most was as soon as I started going to college. That's when I started experiencing more and meeting a lot of different diverse people with different backgrounds. That's when I started getting into relationships. I was told a lot of times that I was really sheltered, and I just did not know. I can't blame my parents for that. They did the best that they could. That's when I started becoming my own individual and experiencing all I could with other people. I think that's my biggest impact, is when I started going to college.
>
> Having been an educator for over 20 years, and as a current teacher educator,

Instructor Teresa draws from her own experiences about biases in the classroom:

> Teachers come in with some type of a bias, and sometimes they don't even know that. A lot of people don't even know they have a bias walking into a classroom. And I think we need to educate our educators with that. And I really - I do think that's really important. One of the things that I stopped doing a long time ago was - and I tell my students this - you know, when somebody comes in the classroom and says, "I need somebody to go to the book room and get books." Who do you call on? Call on all the big boys! So, what are you saying to the females in the

> class, or the 'puny' boys in your class? You know? So, I stopped doing that. I said, "Well, you know, I'll let these people go." Now, I might have to send seven instead of four. But I tried to stop what was the bias between male and female and so forth, like that. And for grading papers, a lot of times, all the teachers chose all the girls to grade papers. So, again, I stopped doing that. It's like, "Boys can grade papers; girls can grade papers." But I think that if we don't recognize some of that in ourselves...and that is just an underlying bias in that example that we can correct in the classroom.

Not only does Instructor Teresa confirm the implication that, however benign, teachers bring personal biases into the classroom, but she makes the important point that they would do well to be more self-reflective in order to address such behaviors. Adding to her remark on reflective teachers, she states:

> I think the place to start is really with - if you're talking about education, anyhow - is starting with the teachers themselves, going out into the classroom, and the unintentional vibes they give off and the unintentional behaviors that they reinforce or don't enforce. So, from where your research is coming, if you can start to identify some of that, then we move that into the education field of educating teachers - I think that'll help start with that, anyhow.

Instructor Teresa's comments suggest that developing a critical awareness of self is an integral aspect of effective teaching.

To varying degrees, these examples of sociocultural influence provide context for understanding the challenges that some PSTs may face when trying to reconcile learned behaviors when teaching in diverse settings. In addition to the above, religious beliefs emerged as another factor contributing to this dissonance, particularly with one's exposure and receptiveness of science.

Religious Beliefs

As mentioned in chapter two, religious ideologies have long been at odds with science. It is a deeply conflictual relationship that has been maintained for centuries. The narratives emerging to form this theme suggest that religious beliefs may work against

understanding human diversity from a scientific perspective. In her account of the sociocultural impacts of schools and communities, Sophia suggests that religious ideology resulted in limited exposure to science, as concepts such as evolution run counter to theological teachings:

> Unfortunately, going to Catholic school for part of my life, science didn't really have much of an impact, because it wasn't it wasn't focused on. It was really lightly glossed over, and also it incorporated a lot of religious thought. So I know now that the science I got in elementary school when it would have impacted me the most and draw my interest is very, very inaccurate, unfortunately.
>
> It was a bigger part [after moving to the United States]. It was focused on a little more, but because I wasn't exposed to it when I was younger, which is when I would like really grasped an interest for it, I didn't really care for it. So, unfortunately, the fact that science wasn't as present in my elementary schooling meant that I just didn't care for it as I went on to school in the States either.

Sophia's comments are grounded in research on international assessments, such as PISA and TIMSS, which indicate that, by Grade 8, students' positive attitudes appear to decline (Mullis et al., 2012; Osborne et al., 2003). Sophia's remarks suggest that sociocultural influences and religious beliefs may contribute to this decline.

Similarly, Amanda notes the influence of religion on upbringing and education, and how it conflicted with her understanding and application of scientific knowledge:

> If you have a closer family, I feel that really would affect it because the culture your family the more they are going to push you and the more that they're going to want to see you achieve and be successful. I think that has a lot to do with it and not only that, but your practice in your own beliefs. I was raised in a Christian household. I would get really uncomfortable in biology to talk about evolution and things like that. It was just like a concept that I couldn't really understand. I just have never really taken to science. And I'm not sure that's why, but it was something that I didn't feel learning it. I didn't want to learn it because it went against my beliefs and it was like that.
>
> That was when I was younger, but now I'm more open to the ideas of different things. Now, I can separate my beliefs versus other people's beliefs and be like, "Okay, well this is a possibility, and this is a possibility, and there's actual

> evidence behind this," and I can wrap my mind around actual things like theories. When I was in middle school I couldn't do it.

Jackie's remarks echo the shift from somewhat constricting religious beliefs toward more scientific thinking and its potential application in schools and society:

> I grew up in the Catholic Church, and as I got to my teenage years I started rebel a little bit and learning about evolution and all that. I became a vegetarian. The more I learned that science and knowing that humans share half their DNA with bananas, you can't really tell the different kids – boy, girl, black or white, Mexican, whatever they are – you can't really judge them on what they look like. But through their personality and their character.

Similar to Popper's (1963) use of critical rationalism to refute untenable ideologies anchored primarily, if only, in one's convictions, as well as Kuhn's (1962) notion of scientific revolutions, it would appear as though Sophia, Amanda, and Jackie experienced a paradigm shift of their own resulting from the introduction to and consensus regarding new (scientific) ideas. Kuhn (1962) argues, for example, that discovery and scientific consensus that decenter normative thinking engender new scientific ideas. Popper (1963) suggests that reaching this point requires critical assessments of otherwise 'rational' information. In this sense, and in different ways, Sophia, Amanda, and Jackie's exposure to and greater understandings of scientific knowledge about human diversity appear to have outweighed previous convictions used to describe such phenomena that could not be falsified.

However, as Angela suggests, espousing a scientific perspective does not necessitate abandoning one's religious beliefs:

> I think science is the base of - I'm a very religious person. I read my Bible every morning. I have a strong relationship with the Lord. But I also believe that science is pretty much the foundation that a lot of this country is built on. I think anything that we do can be looked at from a scientific point of view.

In contrast to Sophia's, Amanda's, and Jackie's acceptance of science, Sheryl is wary of biases embedded in information presented as scientific knowledge and suggests that science itself might require further examination:

> Sheryl: Regardless of what people say, I think science is biased. Because everybody's view on science is different, and it's their view... So, you might understand their view, but you don't understand the whole view.
>
> AA: What do you mean "the whole view?"
>
> Sheryl: One person's opinion on how humans tend to be…Whether you use science or not, it's always biased because of that person telling you…it's not a world view of it. I can't get a majority opinion from just one person.

Sheryl's remarks suggest that she is not entirely convinced that a scientific point of view is always trustworthy. Though, considering the legacy of institutional discrimination and racism in science discussed in chapter two, including pseudoscientific practices such as eugenics, phrenology, etc., her skepticism is warranted.

Major Theme Summary

Taken together, these narratives suggest that the dissonance generated between one's sociocultural disposition and level of exposure to science could be a delimiting factor that impedes the use of science to make sense of the world, as well as human diversity. They also suggest that increased exposure to science can have a positive impact on how one understands the world, irrespective of their sociocultural beliefs.

The narratives associated with this theme indicate a need for greater understanding about human diversity in TEPs, and point to important issues with which educators should be aware when using such an approach. These challenges underscore the potential contribution of CPSP in TEPs, as well as K-12 settings.

From the responses above, it is clear that various social and cultural factors play a large role in shaping how prospective teachers' views prior to entering the classroom. Given that many of the nation's teachers are white and middle-class who teach in increasingly diverse classrooms along with unexamined views of race and ethnicity, cultural disconnections are likely to result in teachers in rather damaging misconceptions of the students they serve (Delpit, 1996; Howard, 2006; King, 1991; Swartz, 2003). However, the question remains as utility of science for teaching about diversity in TEPs, to which Sophia offers a brief rejoinder alluding to its possibilities:

> Given what I know now, it's been a better, influential part of understanding that where people come from and the fact that we're really not as different as we seem like we are. I believe that the only really difference between people is region, because the region determines the language you speak, the culture that you have, the customs that you have, everything that you do, but biologically and scientifically, there's no difference.

This comment speaks to understandings about human diversity afforded by scientific inquiry that can help confront stereotypes and prejudice in schools and society.

"Big Picture" Understandings of Race, Ethnicity, and Culture

From analyses of participant narratives emerged the notion that using science as a means to understand the world facilitates "big picture" understandings of race, ethnicity, and culture. This theme not only serves as an interconnecting feature among the other themes, but also resonates with previous chapters which suggested that systematic investigations and applications of science can offer greater insight about natural phenomena and, indirectly, social phenomena (AAAS, 2010).

Seeing the Big Picture

In the context of the study, narratives suggesting that science facilitates understanding is particularly relevant when teaching about human diversity as CPSP is

itself intertwined between the natural (e.g., genetics) and the social (e.g., race, ethnicity and culture). As the following narratives allude, it is in this way that science can provide what might be considered a "big picture" perspective of a world that all humans share. This theme includes participant responses regarding the insights afforded by science about the natural as well as the social world. Furthermore, whether or not they maintain a scientific mindset about such phenomena, participants often attached a relatively high level of importance to science for what it is able to illuminate with respect to the world around us. Sheryl explains how science shows a bigger picture of the world, but also contends that scientific consensus would be necessary for it to be relevant:

> Sheryl: I think that would be more of a big picture type thing. Because it's almost like a puzzle when you put a bunch of people together and they're all contributing information. Yeah, they're biased, because it's coming from their opinion, but when you put it together with a bunch of other people, you see a bigger picture. Then, you get a better understanding.
>
> AA: Do you think that type of scientific information would be valuable for preservice teachers?
>
> Sheryl: Yes, I think that would be valuable. Because when you're teaching you have to be able to see the big picture, and you have to be able to show your students that bigger picture so that they're not just focused on one person's idea – they have several peoples' ideas and they can put together their own conclusion.

As mentioned, in nearly all cases, participants reported some level of deepened understanding about the world as a result of scientific endeavors, many of whom also emphasized the relative absence of opinion when using science. A prominent view in this regard was that science provides a factual evidence to support its claims, and the implication that such "proof" could facilitate understandings about the world. For instance, Amanda states that:

> People are more apt to listen to what you're saying if you have some scientific proof behind it. If you just come out of the gate and you're just like, "This is what

> I think, but I have nothing to back it," then it's not going to have an impact. But I think having scientific data or anything that can show people, and be like, "This is it. This is real." I think that can definitely change a lot of what people think.

Amanda's remarks suggest that scientific evidence could help allay doubts and have a positive effect on how individuals think about and respond to issues of race and ethnicity in the classroom. This is a point which becomes more evident in related themes; however, in what immediately follows, participants describe their views of how science can be applied to understand fundamental aspects of the natural world.

Understanding the Natural and Social Worlds

Some participant responses illustrated the informative power of scientific investigations for understanding natural phenomena, others extend these understandings into the social world. These views surfaced mainly in relation to activities that address the notion of 'authentic science' which involves applications of scientific inquiry and problem-solving in real-world scenarios to understand different facets of everyday life (Crawford, 2014; NRC, 2012). For example, for Mark, science is informative about every day occurrences often taken for granted:

> I mean, it's all just awesome to learn about…like we were talking about in the classroom, you know, how you can bring science in, truly a lot of things, to help us understand it better is really important. You know, how often we don't think about how - I think you were saying in class - about how we don't think about the physics of a car rolling down the street. But, it's nice to be aware of that kind of stuff, and to take in mind that you're driving this two-ton machine down the street.

Marilyn shares the influence of authentic science in her life and comments on applying scientific information toward understanding the natural world:

> We're very curious family. We would always go to museums all the time. Growing up we did - my dad... I guess I was always just really curious now that I think about it. We went to a couple museums and I was a kid, but when I became a parent the museum became really important, and we bought lots of science

> books, and we did lots of science experiments. Just the natural world - my kids play with - we made more baking soda volcanoes than I could count...Currently, the whole climate debate to me, there's too much time wasted on saying "Look at all these climate deniers." Obviously the climate is changing. Let's talk about solutions. We're wasting so much political energy on climate deniers. It's like finger-pointing. It's just spending time on people who still think the world is flat. It's just stupid to talk about what we know.

Angela offers an account of engaging with authentic science for understanding:

> I remember, probably a year ago, we found a snake in the backyard and we killed it. It's really gross that I'm saying this but to me, as a mom, this was a perfect opportunity to show my kid how a snake digests food. I cut the snake open, and it had two whole birds in its body. So I'm showing my son this, and his eyes are just like wide open. He's so excited to be seeing all this. I know it's probably gross to do that to my child, but to me that's science. You're showing them nature and reality.

For Angela, nature serves as an access point for understanding the world. By involving her son, she seeks to provide him with the same access point from which to develop his own understandings of the natural world.

In addition to "seeing the big picture" of the natural world using scientific data and evidence many participants described connections between science and the social world. When asked about the influence of science in her life, Angela expounds on earlier remarks and relates science to the understanding the social world:

> The biggest part for me is just the simple scientific method. We consistently learn it throughout middle school, high school, even in college. I just got done taking a biology course, and everything you do - you have to approach it that way. You have to make what they call your hypothesis, in your head, and then you observe. You make records or facts... To me, most of the things are observation. Just watching the people. That's why I don't feel like being able to look at somebody's file before they come into a class - I don't think that that's a smart choice. When I was a freshman, I wasn't focused on school. I was more of a talker. But then, the older I got, I got more excited about college, and I started focusing on my grades. So, if somebody would have looked at my file - maybe they did - my freshman year, they may have prejudged that. I think it's better to watch people and treat them according to their actions and not what's hearsay or what's been told. My senior year, I had the same social studies teacher I had my freshman year, and she gave me terrible grades. She was the only class that I ever

> got bad grades in. It was almost like she saw me, and she just already had this idea in her head of who was coming in her class and did not even realize that I had grown over three years into a different person.

Angela's narrative suggests that authentic scientific observation would not allow for such myopic assessments. Instead, a teacher would acquire more data by studying students' behavior in order to avoid prejudicial assumptions.

For Sophia, who spoke very little English when she moved to KMT from a small, Puerto Rican town, technological advances stemming from scientific knowledge that gave rise to social media outlets were influential in her understanding the social world:

> I think where it [science] helped me most is social media, because I would see people discussing things and get interested in them and then find more about it and then learn more about what it is that I was experiencing without actually being a part of it. I guess because I couldn't be a part of it and I didn't know how. So I learned a lot about different issues, like racial issues in the United States, and a lot of problems - a lot about diversity and religion. Definitely the diversity and the different cultures that people have...I didn't know there were so many different people.

Sophia's remarks about using social media to engage with and better understand the social world are redolent of the impacts of social media on various uprisings around the globe. As mentioned in chapter two, nearly 90 percent of Egyptian and Tunisian youth who were surveyed in March 2011 indicated that they used social media to organize protests or to raise awareness about social and political issues (Huang, 2011).

Sheryl offers a different view about technology and the role of science in understanding the social world. When asked what science could tell us about race, ethnicity and culture, she states:

> Sheryl: I think on some levels, it kind of eliminates it, because when it comes to science and technology, the only time you notice race is when you change the language on any devices you have.

> When you use a computer, you can get help on how to set it up in different languages. But, other than that, we start out the same way with technology, regardless of what language you use. So, the cultures of different races don't come into it, when it's about science and technology.
>
> AA: Do you think that any of those applications of science and scientific knowledge could contribute to better understanding race relations, multicultural communities and ideas?
>
> Sheryl: I think technology can bring that into your home, because learning about different cultures and how they do things, you don't have to go out and find somebody else to show you. You have it right there in your house. All you have to do is look it up. You don't really interact with it too much, but you can still experience it through technology.

Sheryl makes interesting observations regarding the interplay of science, technology and culture. In her view, technology serves as a neutralizer of culture as well as an access point. Together with Sophia's comments, these narratives suggest that science – by way of technological innovation – is a function to understand REC and, perhaps, mitigate negative effects from the lack thereof.

To an extent, Instructor Teresa agrees that technological advancements add tremendous value to education:

> I really value the advancements in technology, and how our world is becoming - you know, the health, and resources - there's just so much that technology's done. I love teaching - I only had a couple years with the SmartBoard - I was teaching social studies class and we went to the Amazon River, and you could zoom right down on it and actually see the river and the creatures and stuff from the satellite. That was just a wonderful learning experience, a visual learning experience.

However, as a longtime educator, she also suggests that the overuse of technology can negatively affect one's ability to understand and interact with the social world:

> And where I think we're 'missing the boat' is - I think all of that is wonderful, I think that needs to be a part of our classrooms and moving forward with that - but somehow, I think we've got back off all this social media and all of the 'social' that our kids and students do through technology. Somehow I think we have to bring that back to actual socializing with human beings, not socializing through technology. And to be honest with you, I'm not really sure how to do that.

> And I know I talk to parents all the time, and they say, "Well, they won't do this...they won't go out and play, because all they're doing is on the phone or on Facebook..." and these are elementary and middle school kids, a lot of them.

Instructor Teresa's comments illuminate a different aspect of the conversation regarding the use of technology for understanding. On one hand, technology can open up the world and facilitate 'big picture' understandings of, in this case, natural phenomena that one might otherwise get to experience in such detail. On the other hand, without self-moderation, technology can be restrictive and isolating, thereby closing one off from the natural and the (human) social world.

Understanding Race, Ethnicity and Culture

In several cases, participants' comments regarding enriched understandings of the natural and social worlds using scientific knowledge converged into this ancillary theme which leads to more specific connections of the natural and the social worlds. In this sense, natural and social phenomena are combined using science to provide understandings of REC, such as natural (genetic) human similarity versus social (racial) categories and stratification. For instance, when asked what science might contribute to more inclusive schools and society, Mark spoke of "broadening" the way people view and discuss race through the scientific study of humans:

> I guess when dealing with race and ethnicities, you have really fantastic things that are coming out of anthropology about how humans developed, how cultures developed. So, I think especially that field can help immensely to understand the backgrounds of cultures and how they developed, which can help you immensely in understanding areas like that. It's just broadening people's vision of the world, their understanding of the world. And overall, that's going to help you learn in other areas, too. You know, that kind of background information. I mean, it helps immensely I would say.

Mark suggests that by investigating humanity with a scientific lens, one can reach deeper understandings of race, ethnicity and culture in ways that expanding their view of the world, perhaps, in ways that promote tolerance and inclusion of difference.

For Marilyn, using science to understand REC and "where people come from" has important implications for education as well as society:

> I think it has huge value. There are lots of things that you just need to know is an educated human being...I think there's a lot of value in understanding where people come from if your job is going to be educating people. If you know the origin of humans and how everybody looks different and why we look different, you're so much more informed when you have to take a class on diversity, which is "Don't say these words." You know what I mean? A lot of those diversity training classes are just "These are all the things you can't say." Instead, this is all the science. These are preconceived notions. I thought that [race literacy] quiz you gave about the genesis of laws was really interesting. I think there would be huge value in having that course be a required component.

In highlighting what she views as the substantive contributions of a CPSP approach, Marilyn's narrative indirectly relates to Mark's earlier statements about colorblindness. Her comments reflect literature that suggests that colorblindness is often imbued within a TEP's diversity courses which tend to focus on more superficial elements of human diversity, omitting deeper issues of racial inequality (Brown, 2007; Cochran-Smith, 2003; Hickling-Hudson, 2004; King, 1991).

In the interview Brooke stated rather unequivocally that she did not care for science and does not think about it very often. However, she was no less able to make connections to its potential role in understanding REC:

> I believe that science is very important. Just because I don't think about it doesn't mean it isn't important. But at first, when I saw this study, I was trying to figure out how the two [science and race] were related. But, definitely after listening to your presentation in class, I really can see the correlation between them. I mean, I had no idea that there were no different genes between the races. I think when you tell people that it definitely hits home and makes them realize that we're really not so different. I think when you tell students that it makes them more accepting of

> people that aren't like them, and more ready to talk and interact and feel more comfortable...in today's world, everybody has come up with their own conclusions as to why everybody's so different, and they're really not accurate at all when you look at it from a scientific point of view.

Along with "seeing the big picture" (i.e., understanding the natural and social worlds), these narratives illustrate how science might be used to facilitate deeper understandings of REC and also address its potential to help address challenges PSTs might face when teaching in diverse settings by understanding human similarities.

Human Similarities and Race as a Social Construct

This concept emerged in in similar discussions regarding the informative potential of science for understanding REC, and particularly race, both scientifically and socially. Some of the responses regarding the use of science to understand REC highlighted human similarities as an integral component of doing so. Angela points out, for example:

> I think, many times, we're making judgments on color of skin and preconceived notions. It's almost like science could prove that we are all the same, and it doesn't matter who you are and where you came from. We all need to educate ourselves and be better to the world into each other. However science could go at that - that's how it needs to go.

Jackie adds that acknowledging human similarities does not exclude one's particular family customs or cultural traditions. Rather than dissolve cultures, her comments suggest that such understandings help create space for them to exist:

> I think it helps. I think if we teach people from a young age that that's true - that were pretty much all the same; that our differences are based upon where were born and who are families are - I think we can also have our different traditions and cultures. But we can share them with every one instead of being segregated - we are still really segregated. We can come together and learn about each other and not go, "That's wrong! You're doing it wrong!" and just accept what people do.
>
> I think it is important just because in the generation that my grandmother grew up in - she's white and she talks about hanging out with a little black girl. And she talks about it like they're not all just kids hanging out - there are these white kids

> and then there are these black kids, and then they just happen to mesh together. And it was like, "Well, yeah, you're all just kids." They weren't taught that they are the same, they're all just kids. And if we teach our generations and the next generations that there aren't really any differences, I think they will grow up to not have racism - there just won't be any point.

Sophia agrees with Jackie's statement:

> I think it would make it easier, because even as we set ourselves apart from each other, it made me feel very alone. So, having that information to rely on you could be like, "Hey, they might be from somewhere else, but we're in the same situation, and we have the same origin. We're going through the same experience. We're really not that different. It's okay."

Anna concurs and connects her understanding of human diversity and similarities to the information gleaned from her science classes:

> Anna: Taking those classes, I feel like it shows that we're all the same.
>
> AA: Do you think those concepts can contribute to better race relations in schools and society? If so, how?
>
> Anna: Absolutely, they do contribute a lot. A lot of students view other students based on appearance or physical appearance. That's because they haven't really developed their true identity, and they're just kind of lost out there. They judge other people by their appearance. If they were to actually know how we're made up on the inside and what defines them as people - not only how we're made, but how we are different with our attitudes and everything else - as you intertwine that together and show that we are the same, even with our emotions, but we are different. I don't know how to say it. I think that it's important for children to know that science aspect with our DNA. That should be emphasized in their learning.
>
> AA: Do you think that would help teachers reach their students more effectively?
>
> Anna: I do. But I feel like the way I see it, I think we need to focus more on how much we are similar. For example, we have the same amount of bones in our bodies. We're all the same, but depending on how much melanin we have in our skin, we see that minor stuff that we see.

Anna's relationship with science leaves little question in her mind about what science can reveal about human diversity and the similarities therein. In addition, given that she would ultimately be a science teacher, Anna was insistent about developing her

ability to implement science and human diversity in her future classroom. She states, "This is a big thing if I'm teaching chemistry! How do I implement that?"

Instructor Jeremiah is similarly convinced of human similarities:

> Human diversity - it's the science. As a science student, I have always believed that all humans are the same, are from the same origins. So, for me, it's never been a question. It's a 'no-brainer,' because I believe in science.

A trained biologist, Instructor Jeremiah maintains a clear perspective of the science that justifies human similarities. Extending the discussion, Mark notes that race is not biological but rather a construct of the mind:

> I'd say the most obvious point would be that science disproves the idea of race - that it's a social construct that we constructed - and really any kind of political and economic ideology or whatever. You know, when you look at the 1800s and you have things like eugenics and all that kind of stuff. And today, science has come out that shows that that was ridiculous - things like that. And specifically with race and culture, again, it helps disprove the social construct, and with things like gender - things like that. So, it's very important. At the same time, I think it has its limitations, too. Where, specifically, if you were to teach that race is a social construct, I think you'd also have to combine that with the idea that, while race is socially constructed, the oppression based on race is very real.
>
> So, it needs to be combined with that, in my mind, to really be effective in talking about race and things like that.

Mark's response is indeed grounded in scientific fact, and also illustrates that deeper understandings of race help put into perspective the realities of social stratification on the basis of racial categories. His comments suggest that science reveals race as this product of disillusioned social opinion. Similarly, Amanda references a point made during the class discussion to express her views about what science reveals about race: "I think, as far as race goes, you said it very well - didn't we just make that up?"

Sophia shares her view of what science contributes to understanding this concept:

> I think it [science] can tell us everything about race.

> Science can boil down a human to their DNA. It can tell you everything, because that's what we are - we're DNA, essentially. And science has the ability to tell us what our DNA is composed of now, and DNA can be trace back to anything.

Sophia's remarks speak to a fundamental 'truth' about understanding the natural and social worlds in relation to REC, which Instructor Jeremiah helps explain:

> When people are given wider scopes of knowledge, which science affords in its most elementary way, everything begins to make sense. And that is the reason why science is very compelling, because science forces you to your knees and makes you obey the laws of nature.
>
> When you understand wider scopes of disciplines, then you are actually approaching the original intent of what we call science, which is nature study. Anybody who observes nature understands sociology. I mean, what is sociology?
>
> It is the study of communities, actually. In ecology we do communities, don't we? Ecology is communities. "Ecos" is literally the study of the home -
>
> I think that's really, in a way, that's why biology becomes interesting, because biology forced me to wonder more about everything. So then, all of a sudden you're interested in sociology...anthropology. It's all there. It's really the science of nature. And, in a way, that's basically what you are saying: to what extent does the science of nature engender an understanding and more embracing of everybody.

Instructor Jeremiah posits an interconnectedness of the natural world that through scientific inquiry helps understand aspects of the social world. For example, that that race is a social rather than natural (biological) phenomenon. He then explains how in the absence of such scientific thinking unexamined truth claims are able to construct stratified social categories (e.g., race) and subsequent inequities in a society:

> When you look into all societies around the world where they are more metaphysical than science, they are not progressive. I mean, look at India. And it's very interesting, and a rather ironic twist. Where you have some of the best so-called gurus on earth, living side-to-side with some of the poorest people on earth. They have created something akin to human filth, which is really sad. And they have created these hierarchies of human existence, that kind of thing, which doesn't make sense. Those kinds of things don't make for human progress. So, in a way, people who decide by mental propositions which may be faulty, at best, and impose those for realities, all of a sudden creates societies of inequities. So, you

> have the “untouchables” and all those - you go to China, you have the emperors; you go to Europe, you had the gods and the laws. And you have all these systems. And then, all of a sudden, the science comes in to explain advancements - you know, where rain comes from and the 'rain-god' dies. Because, all of a sudden, we know the water cycle. Okay? We discovered the emperor has no clothes. So, we don't need a king or queen, so they lose their positions. And so, what is interesting is really, how all these rather silly human creations, which are intangible and unscientific then crumble under their own weight because they are artificial human creations and do not stand up to scientific scrutiny.

The foregoing remarks ultimately suggest that science facilitates understandings about the natural and the social worlds by broadening and deepening perspectives regarding human diversity (i.e., REC) using scientific knowledge and principles. With these new understandings of REC that diminish social categories such as race, PSTs are better equipped to create space for equitable and inclusive learning environments.

Major Theme Summary

Narratives in this theme describe how science can be used see to a ‘bigger picture’ of the natural and social worlds that facilitates deeper understandings race, ethnicity and culture. Participants suggest that science not only expands one’s views of the world at-large but also provides insights for making distinctions between natural and social phenomena such as genetics (biological) and race (social). For example, one of the supporting concepts for this theme, *human similarities,* includes natural phenomena such as genetics which can be examined scientifically. Whereas, for the other supporting theme, *race as a social construct,* one could use genetics to understand that, scientifically, stratifying society on the basis of race is the equivalent of social stratification on the basis of eye color. One implication is that by making such distinctions, prospective teachers would be less likely to conflate these discrete concepts and therefore resist debilitating assumptions about students based on racial categories.

Racial Anxiety and Apprehension versus Meaningful Dialogue

In this major theme, some narratives express apprehensiveness about discussing or confronting race-related issues, while others suggest that using science to understand and discuss human diversity can help create reduce racial anxiety and encouraging more meaningful dialogue about such issues.

Marilyn shares her apprehension about addressing race-related issues or incorporating strategies similar to those in this study in her future classroom:

> AA: Do you feel that with the information that I presented we could have continued that discussion? Did it give you the impression that we could start to unpack this a little bit?
>
> Marilyn: It did actually. It did feel like that. I'm a fairly educated, experienced person - listening to your lecture, and it was really informative and really interesting. But there was part of me that was thinking, "I don't know if I could be this frank if it was me instead of you giving the class."
>
> Because I'm a white person, or maybe it's because I'm older - I'm another generation older than you - I don't know. I'm not concerned having this conversation with you on the phone, but some kid might take something wrong that I said...I would be a little nervous. What if I said something the wrong way, or it started a conversation in my classroom that somebody said something and then I lost my job?

Although Marilyn was receptive to CPSP, her responses suggest that teachers may be reluctant to use such an approach to avoid discomfort or for fear of losing their job.

Angela shares Marilyn's concern but feels that using verifiable information to negotiate such discussions makes the challenge of apprehension a surmountable one:

> To be honest, the way that girl in class was talking about - I'm just more nervous about saying or presenting something in the wrong way, where it's not been that way, but in my opinion it shouldn't be taken in a bad way. To me, that's the most concerning thing. I hang out with people from Puerto Rico, Panama. I have black friends, white friends, and all of that. I get along with all of them really well, and we're all really close. I'm just more concerned with somebody misinterpreting something I say.

> I've always wanted to teach. A lot of the fear of teachers right now is losing their jobs because of a parent suing them or a student saying something. You're eliminating one of those things. You're taking it and saying "Here's a good way to talk about the situation" without putting yourself in it or putting anybody else in it. You're looking at the facts

Upon graduation, Brooke will join approximately 83 percent of the teachers in this country who are white, and another 76 percent who are female. However, she was apprehensive about the prospect of being in the minority at a culturally diverse school:

> I've always pictured myself teaching in a school very similar to the one I went to. Now that I'm here, I'm thinking, "What if I student-teach at a school downtown that is full of people completely different from me?" And I don't know, I guess you just don't address the differences and you have a classroom discussion, call on people equal amounts - I don't know. I feel like if you talk about it like you're comfortable about it, then they will feel comfortable about talking about it, too.
>
> I feel confident in the fact that I will be able to treat everybody in the classroom equally, but it does make me nervous to go into a school where I might be the minority, and to have students looking at me, and judging me, and me being on the reverse side.

Though, when asked about social justice and addressing human rights issues in the history classroom, she suggests that, in spite of this apprehension, confronting and overcoming any such discomfort may be a necessary aspect of teaching history:

> I mean, both of those are very important aspects of history and you can't escape the past. You have to address it. And I think it's important to address either way. Just because it makes you uncomfortable doesn't mean it's not important and it doesn't need to be talked about.

Sophia's apprehension stems from an uncertainty of whether she could adequately implement CPSP strategies in her future classroom:

> I would feel comfortable once I learn how to do it properly, because I wouldn't want to give misinformation. I wouldn't want to say something that's not true, but definitely I would feel comfortable using it, especially because if I were to go in to teaching English as a second language.

She also expresses reservations about teachers' receptiveness diversity, with regard to their ability versus their willingness to incorporate CPSP into their instruction:

> Circumstantially, I think it'll contribute to understanding to the people that care. But from my point of view, there are just people that don't care to understand race, ethnicity, or culture and the presence of science isn't going to make a difference to people that just aren't bothered to learn.

Sophia raises an important point about the tenability of CPSP and its potential to more broadly affect society. In relation to the preceding narratives, her observations highlight a fundamental concern with any type of reform: the extent to which the public will gravitate toward new ways of thinking. One implication is that, in spite of a teacher's ability to confront issues of diversity in the classroom, their discomfort and apprehensiveness may ultimately dictate the willingness to do so.

In contrast, extending her earlier remarks about using science to understand REC, Angela connects scientific understanding to desensitizing discussions of race:

> I think if we could get the things like race and stuff in that same way to use the science to make it not such a touchy subject but more of an interesting and fun subject, to educate would be awesome.
>
> If there wasn't so much time spent on the nervousness and the tiptoeing and all that, there's so much more time that could be spent letting these kids learn more things that had substance, that could better their life. So, when they get out in the world, they're not like, "Be careful, there's a Spanish [sic] person. I can't say anything about that. Let's not talk about that." That's ridiculous to me.

When asked how and the extent to which the information in the class discussion using CPSP was a viable for understanding and improving race relations, she adds:

> The data, being able to use that and the way you presented it kind of made me feel more comfortable; that if I ever have to deal with a race issue coming up or cultural issue that you don't have to have an opinion about it. You can use facts. Then it's not your way, it's the way that's been proven. I think that's the best way - just finding that kind of information that you presented, and just using that to the advantage of, like you said, proving where people come from, what their relation is. People can either turn a blind eye, or they can educate themselves. That's the

> best way to going to happen - if we get people to stop looking the other way and start paying attention to the facts.

Angela's narrative suggests that understanding human similarities and using scientific facts may help reduce teachers' anxiety and the earlier mentioned apprehension about issues related to race and ethnicity, thus encouraging and facilitating more meaningful dialogue about the same.

When asked if she could imagine a scenario in which CPSP could be used in an English classroom to facilitate discussions that involved sensitive topics such REC, Amanda responds:

> I know when you're teaching 18th and 19th century literature, or when you're learning it, there's a lot of different ways that people portray how they feel about those times. And we just had a class...we were learning about Young Goodman Brown, and they were talking about his life....and it turned into a huge argument. It was not a fun class. I think if people had a better understanding of how other people will think and come to those conclusions, or if they thought about that and how people are going to think differently, I think the class may have gone more smoothly had those issues been addressed.

In suggesting that science would facilitate such dialogue in other classrooms she makes an interesting distinction between the mathematics and the humanities:

> I think it would definitely be more helpful in discussion classes. I think I'd be able to implement it more in an English setting, because it's so open thinking and analytical, versus a math class where everything is like, "This is the answer, and this is what you're going to get. No matter how many different ways you think you're going to get it, this is how you're going to get it." And definitely in art, or music, or literature and things like that, you can express freely as far as like what you're thinking and all that.
>
> If you help your students be more comfortable with the culturally diverse classroom, I think that opens up a lot of discussion. I think it makes everyone more comfortable and it's easier to learn in that environment you feel comfortable to say what you think. I think helping students understand that - and it would be boring if everyone looked the same - helping them understand would be a lot better.

Amanda suggests that using science to reduce race-related anxieties in class discussions creates a more inclusive learning environment. And yet, while she acknowledges the potential of science to create an inclusive atmosphere in the classroom for English and the Arts, because they allow for discussion and free expression, she imagines that mathematics is perhaps too rigid to include a CPSP approach.

Brooke agrees that incorporating science in discussions of diversity is helpful and also fosters a sense of equality in the history classroom:

> I feel like I will definitely bring it up when anything about diversity comes up in history. I feel like it's important to remind everybody that just because it happened doesn't mean it's right.

Similarly, Mark believes science could support meaningful dialogue in history classes, as well as much a needed public discourse about race:

> I mean, for me, overall, this is just something important to think about teaching history. So, it's good - it's nice to talk about it, I guess.
>
> Yeah, without a doubt…there is no racial or ethnic dialogue really in this country, I find. So, if it's not being talked about, people aren't going to pick up on it or be aware of it, unfortunately. It should definitely be something that people go through.

Amanda agrees with Mark, and suggests that education is a good place to start:

> It would definitely help to introduce in society, but I think it really starts with education and in the education system because everybody goes through that and obviously we need it in our society. I think the best way to reach the mass would definitely be through the education system just because you have to at least go until 12th grade.

Marilyn extends the discussion with remarks on the educational and social utility of applying scientific concepts to understand human diversity:

> It seems like people are really afraid of talking about race. Hopefully we're moving to a place worth less difficult to talk about it. I think probably it's not just white people. There are probably a lot of other cultural groups that are free to talk

> about race. There has to be a way of constructing the lessons where people can feel really safe talking about them.
>
> I think helping people put the focus on our cultural differences and things like the lack of opportunity that makes us different, not our biological differences. So just putting the focus on where the difference is. Making assumptions just based on skin color - that's just for ignorant people…I feel like the more we can talk about the science, then we can focus on lack of opportunity and real issues that make us - not just different, like kinds of economics, but just different - everybody wants to be with people that have similar interests. It's just when you make value judgments on it that people get hurt and killed, like that kid in that gas station, because he was listening to - I forgot what that guy called it - jungle music or whatever. That's what we have to fight against.

Marilyn's comments are germane to the larger implications of CPSP in schools and society. One of which is that using science to facilitate race-related discussion would create space to address other social inequities as well.

Successful Teachers in Diverse Settings

These concepts correspond with participant narratives that describe what it means to be a successful teacher in diverse settings and either directly or indirectly address general qualities of responsive teaching. In line with previous themes, there was a shared sense among respondents that, irrespective of the subject area, using science to teach about diversity was a feasible, if not essential, aspect of developing truly responsive teachers and fostering inclusive learning environments. Given the implication that CPSP could facilitate meaningful dialogue about such issues, these descriptions illustrate the types of responsive educators CPSP is able to support. For instance, Mark suggests that responsive teaching in the history classroom might include empowering students from all backgrounds to critically engage history using their own voice and cultural lens:

> To be a successful teacher in a history setting, for me, it would be addressing the particular racial or ethnic group in history to make sure that they get a sense of connection to it. As compared to, especially US history - it just focuses on white figures and things like that. Also, in history, a sense of voice. Because, to me,

> history is more of an argument. So, I would want to encourage students to interpret history through their own tools and things like that - to come up with their own conclusions about events. I would just want to try to foster a sense - where they could bring in their racial or ethnic background and use that to interpret history.

Kathryn describes how her high school teachers were responsive to students from various backgrounds and the impression that made on her:

> I think what's been most influential is that my teachers at [high school] put a lot of importance on having respect for everyone in the classroom, and making sure everyone was treated the same, no matter what their background was. And I think I've learned from that a lot.

Anna is very passionate about learning and teaching science, and feels that education was a good fit for her because she can use that to inspire students. When asked what draws her to education the most, she responds:

> What draws me the most? I do want to help people, and I love working with children. In becoming a teacher, I feel like I can put passion in somebody's heart. I'm very empathetic, and I really want to work with kids. I feel like teaching would be the correct way to go.

She is also confident about teaching in diverse settings, and points to language as an entry point for cultivating an inviting classroom and connecting with students.

> AA: Describe your thoughts about teaching students that might be culturally different than you – racially, ethnically, etc., and how confident do you feel in teaching those students?
>
> Anna: I know whether it be in any district I teach in, there are going to be racially and ethnically different students. I feel like I would be able to do that. I don't have any doubts that I won't be able to. I never really - I mean, I've thought about that, but I have not really considered it. I don't feel like I will be incapable of it. As long as I don't exclude anyone and just make everybody feel equal.
>
> AA: You said you wanted to "make everybody feel equal." How might you go about doing that in your classroom?
>
> Anna: Definitely through language. Even something as simple as saying "we." Just having everyone feel as one. Knowing everyone's ability when I get to my students, since everyone is different. That shows through their background, their

> home life. Just integrating a positive lesson plan and how all the students can interact is one, I feel like adds a great way to have everyone feel equal.

Guided by an empathy for others and her passion for education, Anna points to the use of language and differentiated instruction in ways that promote a sense of equality as responsive modes of teaching. Using CPSP to facilitate meaningful dialogue about sensitive issues supports creating such a learning environment.

Sheryl comments on being responsive to culture in the math classroom. She conceptualizes responsive teaching as a form of culturally differentiated instruction:

> A lot of people say math is the same no matter who you learn it from, who teaches it, where they come - math is the same, but it's not. Because the technique and the application of how math is taught is different from culture to culture. And when you have a diverse classroom, sometimes you have to go with whatever culture that student knows, because that's how they learned the basics. You're able to teach them your way, but unless your way can connect to the way they learn, it's not going to help them with the subject.

Similarly, Amanda contends that responsive teaching includes being adaptable, open minded, and avoiding prejudicial assumptions:

> You have to adapt to everybody's needs, and their strengths and weaknesses, whether that be cultural or academic.

> You definitely have to keep an open mind. Going into it close minded, children are going to think the same way. And even adults - you can't think all adults are going to think the same way. You have to get to know before you assume. You can't put everyone in one category. If you do that, then you are limiting yourself to a very minimal amount of knowledge.

Jackie adds:

> Each interest, you relate to something in the world. In science, you relate to biological evolution. And in history, America itself has come from different countries – and all of our different histories – everything has something to do with people. So, you would have to know not to judge people before you taught your students anything.

In agreement with Jackie and Amanda, Brooke states:

> You need to know about different cultures and different traditions. Get to know more about where these people come from, and their home life and what they're used to and what they respond best to, in order to be able to communicate with them and teach them as best you can.

Instructor Teresa draws from her years of experience as a teacher educator and behavioral specialist to provide context to the discussion:

> I think to be really, really successful at teaching, and at learning, but especially for students to learn, especially students that are challenged to learn, they definitely need the structure but they also need some free-flow, some creativity to it. They're not just going to sit there and memorize in rote, they're just not going to do that, whether they can't do it or they're not going to do it because they're not motivated to do it. So you have bring that kind of artistic creativity into the classroom along with their structure and their content and try to be - you know, every day is not going to be a dog and pony show, it's not - but like I tell my students, my [TU] students, at least if you can try to incorporate something with them - a creative lesson, as much as you can and come in with little tidbits, or just keep surprising them each day with something

Sophia takes successful teaching another step further when describing the type of responsive educator she intends to be. Interestingly, she was the only participant who to explicitly suggest that responsive teaching also occurred outside of the classroom:

> As an educator, I would probably talk to students outside of class and make sure they're okay if they're understanding, and see if there are any resources that I can accommodate them with, but during class definitely I wouldn't treat them any different than I would treat the other students because they are capable of doing everything that American students are capable of doing. It's not fair for them to feel like they're not, only because they are culturally diverse.

Jackie also spoke at length about the need for teachers who can inspire students to stay in school, and her subsequent desire to be such an educator:

> I don't think that education in this country is what it should be. I think it's sad that kids don't get to experience – like my school didn't experience – any diversity. And there are kids that have to go through security to get into school. And there should be teachers that they get see that inspire them to do better in their lives. And then yesterday we had the speakers from Uganda who spoke about children walking six kilometers or eight kilometers to school and being so eager to learn through terrible circumstances. And I think anybody who's in the education

> program especially should learn about what other people have to go through in order to understand how teach the people who have to struggle in life.
>
> My dad didn't graduate high school because he didn't have anybody to inspire him. And he could have done a lot more with his life have had he finished high school and gone to college. And there are a lot of students that don't see the point in high school or college. And maybe I can't make them realize that, but maybe I can help them stick with it until they graduate.

Jackie's concern for education was evident throughout the interview. Her comments suggest that education supports social mobility and that responsive teachers are those who help students understand its inherent value.

Along with narratives in the *Racial Anxiety and Apprehension versus Meaningful Dialogue* theme, the foregoing descriptions of successful teachers in diverse settings illustrate the types of responsive educators CPSP can help promote.

Major Theme Summary

This theme discussed the need for meaningful dialogue about issues of REC in schools and society, and that the ability of science to provide supporting evidence allows for seeing a bigger picture of the world such that human diversity was viewed more the ironic parallel of human similarity that reduced race-related anxieties than the contentious and divisive network of uninformed diatribes it has become. One implication is that CPSP strategies could inform such debates within and beyond (science) classrooms and schools, and into the public discourse.

Furthermore, the supporting concept of successful teaching in diverse settings highlights aspects of responsive teaching that align with subsequent narratives which discuss the applicability, accessibility and adaptability of CPSP in TEPs and K-12 settings. Together with the views expressed throughout these findings, this theme suggests that CPSP may well be a substantive approach to various forms of responsive

teaching in diverse settings and a starting point for meaningful discussions about human diversity. It also suggests that having sound applications and pedagogical practices are essential tools for achieving this goal.

Applications, Strategies, and Impacts

This major theme emerged from narratives related the potential impacts of applying a CPSP strategies in schools and society to understand and discuss issues of diversity. All respondents suggested that using science to learn about human diversity in education would be beneficial. Most suggested that it would assist in teacher preparation, while others suggested ways this approach could be used in TEPs or in K-12 settings. Some participants offered strategies for using science in ways that directly align with, supplement or extend CPSP, in general, or in their future classrooms. In addition, throughout these narratives are implications that using science to understand human diversity is relevant to for teachers of all academic areas. Some suggested that CPSP may have a cross-discipline accessibility that would allow it to be seamlessly integrated into any subject area or that it would complement differentiated instructional strategies. Brooke states, for example:

> On the very first day of class - whether you're going over history that day or not - when you present the syllabus and everything, I feel like definitely that's something that needs to be addressed. Especially in history classrooms, because you have to have a lot of discussions.

Mark speaks to the implications of using a CPSP approach in teacher education:

> It's like the thing we worked on in class, that "race literacy test." I don't think a lot of people know about these kind of things, so it's important to get that kind of information out there in the day-to-day... And in the classroom, I would think it would just help understanding particular students. Without any sense of cultural awareness, any sort of problematic thing they [teachers] might see as behavioral issues... So, having science behind you can help cultural development. You'd be a lot better at managing your students by understanding your students and where

> they are coming from, which I think would help you develop a much better relationship with a student.

The "Race Literacy Quiz" that Mark (and Marilyn) refer to was administered to students at the beginning of the class discussion in this study (California Newsreel, 2003). This 'quiz' asks a series of questions related to science and history as well as racial, ethnic and social awareness. Its purpose was to highlight the importance of knowing about issues that disproportionately affect certain racial groups. The narratives from Brooke and Mark suggest that it quiz might be a good way to implement CPSP.

Teacher Education and K-12 Settings

As earlier suggested, the value of science beyond the science classroom was a common view among participants in discussions of the utility of science for learning about human diversity. When asked if they could envision a CPSP approach being implemented in teacher education, the consensus was that it would indeed be beneficial:

> Kathryn: I think it would be a good idea for all teachers to take a class on science with diversity itself, because the science aspect of it proves it true - there's no arguing it really. I think it makes other people believe it - it makes it more believable.
>
> Anna: If you're specifically in teacher education classes, I most definitely do see that as being important. That's what we need to learn in order to apply that when we would become teachers. It's the reality we're going to have to face. We need to know now and be educated with that and further address that in the future. It's just little things - not little things - the big thing we don't think about really. It's really important to know that now and to keep that in mind. Like I said, I haven't really thought about that. It is very important to have us learn about that now in teacher education courses.
>
> Sophia: I would it would be beneficial for any education classes. I think it would be beneficial for any education classes that - in the specific instance that I'm thinking of, it would be really beneficial in the intro to special education class, for example, because a lot of people like to set themselves apart from kids or students who need special education, for a lack of better words. But, regardless of circumstance, we're the same. I think information like that would be very nice to incorporate and to have just the kind of get rid of the stigma and to stop people

> from setting themselves as far apart as they do from people that require special education.
>
> Marilyn: Yeah, I think it is really valuable. I think that would be a great course for teachers. I think if you're developing curriculum it has to be 'real.'

These narratives indicate the applicability of CPSP in teacher education. Participants consistently reference the value and benefit of science as tool that informs through its ability to deconstruct well-worn ideas about race and human diversity. The implication is that CPSP would make a valuable contribution to TEPs and would support the development of effective teachers who were more critically aware of the imposition and harmful effects of social norms such as race.

Participants were also asked whether using science to address diversity in TEPs would be more fitting as a standalone course or as an additive to existing courses. Most said a standalone course might be most effective; however, all participants thought that, at a minimum, it would be helpful as an additive to multiple courses:

> Amanda: I think probably a standalone class - there's so much to learn on it. You can't just plan to do what we got out of it and then expect people to actually take something from it and use it. It would definitely have to be an entire class where you sit down and you help future teachers, and let them know that this is what you got to do, because it's more embedded...An entire course of the science of it alone I think it would help tremendously.
>
> I think it would be helpful either way. But if you just plan on doing it for a week or two, it's going to stick with some people and with some people it's just going to be brushed right off. If they do it a week before they student teach, and if they go to the classroom and they utilize it for that week, it may stick with some and, for some, it may not. But if you have an entire course and if you're practicing and applying it, it's definitely going to leave an impression on people... It would definitely still be helpful just to have that, but I think it would be more effective to have the entire course.
>
> Angela: I definitely think it's something that needs to be taught, whether it's as a full class on its own, or just in a teaching training program. Whichever it is, it's obviously a touchy subject for people right now, especially everything that's going on in the world and the way people are being treated. It's something that

> needs to be addressed before we get into the classroom and we're like "Uh-oh, I am not prepared for this."
>
> Mark: Oh, yeah. Most definitely. I imagine it would be so much better if it was just a specific course, not just for teachers, but everywhere.

Brooke feels that adding science on a class-by-class basis would be sufficient:

> I think we've worked it into this first class pretty well and I think it could just be mentioned in each education class you have to take. I don't know if this should be a whole class in itself.

While a minority suggested that it would be best as an additive, all participants agreed that this approach would make a valuable contribution to teacher education.

When asked about other educational applications, several participants indicated that CPSP would be useful in various capacities in K-12 settings as well. Amanda states:

> I think anywhere that anybody can learn about it would be - anytime that you can take that opportunity. Because teachers, now, they're not - this isn't something that they were even considering 10 or 15 years ago. I think getting people and sitting them down, no matter what age, I think it would still be helpful, definitely, to help older teachers into a newer generation and a new way.
>
> So, [with] the idea of races, it would definitely help to apply science and the history of the people that you are trying to talk about to reach an understanding as to, in my case, having to explain to them what they just read.

Amanda suggests that new and experienced teachers would benefit from CPSP. She also mentions how she could use this approach to help explain readings in her future English class that include sensitive topics involving REC.

Sophia views CPSP as a way to address differentiated instruction:

> I think it should have a role in the school level because when it comes to understanding culture and society we often look towards Language Arts and Social Studies and those two. Although they are a very good component for understanding different cultures and race in society on their own, they don't appeal to every mind that the students would have, like some students leaning more towards the sciences, some lean more towards the arts, and some lean more towards languages. Does that make sense? I feel like students that lean more towards sciences don't have that kind of understanding to fall back on because

> science is not focused on much to understand race in society, but I think it would be very important component if it gets incorporated properly.

Sophia's comments suggest that a CPSP approach would be beneficial to discuss REC which, she notes, science hardly does, but also to appeal to different types of learners. Hers was one several ideas for CPSP strategies that were generated by student participants in this study.

Strategies for Implementation

Kathryn enjoys learning about other cultures and views such knowledge as a valuable part of the educational experience. She imagines variety of ways to infuse a CPSP approach in a K-12 setting:

> Yeah, one hundred percent. I think it would be cool for a high school course just to have a whole course on diversity and learning about different cultures. Even in English classes, with the 9th grade literature or British composition, there should always be some sort of learning about different cultures and diversity even within that. Obviously, in literature, you are learning about different cultures, but shining light on every culture... you can always do that within whatever course. Even if it's a math course learning about different... calculating the differences in genes or just whatever. No matter what course or specific topic, you should always include something... so that the students can see the differences and the similarities with other students, technically.
>
> It's just common knowledge, really, being able to share that. I think even if I was an English teacher, it would be an interesting prompt for students to write on.

Although Kathryn is an aspiring English teacher, she mentions several subject areas in which CPSP could make valuable contributions in K-12 settings. Notably, though not to dismiss or belittle Amanda, one of the other aspiring English teachers in this study, Kathryn found a connection to mathematics (i.e., "calculating the differences in genes"). In addition, she offers very insightful ideas including a high school course on diversity, as well as using CPSP topics for writing prompts in her future English classes.

Angela, also an aspiring English teacher, explains how she might incorporate CPSP in her future classroom which includes strategies used in this study. Specifically, a video entitled "3 Ways to Speak English" that shown to the class at the end of the CPSP discussion to humanize and to contextualize the scientific discourse presented throughout. In it, poet and educator Jamila Lyiscott confronts misperceptions of intelligence in society based on how a person looks or speaks, using spoken word poetry (Lyiscott, 2014). Angela's comments also addresses the cross-curricular accessibility of CPSP, as well as the importance of differentiated instruction and responsive teaching:

> Honestly, I would probably use your technique. Give some facts, and maybe show some videos. Everybody doesn't learn the same way. You've got to have the ones that you can talk to and explain things to and show that, and then you've got to have the ones that you move by videos - like the girl that was speaking. I got chills when she was talking. With things like that, you can get to different people. Some people are creative. Some people are just there to be there. You've got to hit everybody in their sweet spot.
>
> With English, it's a lot of breaking things down, pulling them apart. You're dissecting words and sentences and trying to see how I can relate to you or how you can use it later on. If it's a book that is cultural, ethnic or racial, that's probably how I would handle it. I would just pull it apart, give the facts about it, and let them see what it is. As questions come up or discussions start, then I would probably approach that as it came.

Angela acknowledges that reaching the most students will require various strategies, in order to find their "sweet spot" and keep them engaged. She also appears to equate analytical aspects of English with the deconstructive elements of CPSP.

Cross-Discipline Accessibility and Differentiation

Similar to Angela's and others' previous comments, some participants brought up the cross-disciplinary accessibility of CPSP and differentiated instruction, and at times, the interdisciplinary features of education. When asked if were possible for to easily integrate CPSP into their lessons without being a science teacher, participants on the

whole suggested that was a possible, and many felt that it may be necessary. For example, Brooke suggests that cross-curricular teaching and differentiation helps galvanize important topics in the learning process.

> I definitely thought it was neat, like, when I was in high school and I would be in history class and then all of a sudden we were talking about a book that I was reading in English at the same time or talking about something I had learned in science the year before. I always thought it was neat when they all kind of ran together...I think it's important to tie all these different subjects together. It makes it more important.

Sophia believes that any teacher can relate other subject areas to the one they taught, they need only the will to do so:

> I think with proper training anybody can do anything. I mean, any teacher that would be willing to do it could do it. Teachers can find a ways to incorporate... like, chemistry teachers can find ways to incorporate ice cream into lessons. So, if you can incorporate dessert... I remember very distinctly in middle school we were trying to find a way - no, in high school I was taking a Chinese class and we wanted to order Chinese food, so we decided to have a lesson on chopstick etiquette. But it was just an excuse to order Chinese [food]. So, teachers can find ways to incorporate anything into their lessons if they try hard enough, and with proper training and proper information - with the proper tools in their 'toolbox' - any teacher can incorporate this information about race and ethnicity and origin into any of their lesson plans.

For Jackie, the cross/interdisciplinary nature of education is requisite to a well-rounded college experience:

> I think another thing is that people get stuck going, "Well, I'm an English major. I don't want anything to do with science."
>
> That's the whole point of college, is you don't just do English in college. I'm not just in Spanish. I'm in astronomy and I was in math. And that's for a reason because we need to have a - what do they call it? When you're well rounded. You need to be well rounded in your life. So, if everybody is just well rounded because they got a good education, then we'll all might just get along.

Some responses included, more generally, the idea that CPSP strategies would be valuable for all teachers.

> Amanda: Yes, definitely. It'd definitely be useful as far as - I mean, I can't strictly rely on my knowledge of literature to get through class.
>
> Marilyn: I think it should be for teachers. It should be for anybody teaching. That quiz that I took I thought was really interesting…I would take that to the first meeting of my French class or the second week of my French class

Brooke suggests that CPSP would be a good way to start any class:

> I think no matter what subject you're teaching, it's important to bring up on the first day of class that everybody's going to be treated with respect and everybody's equal. And you could definitely bring up that scientific point of view to show that everybody is the same.

Although content mastery is essential to high quality teaching in any setting and vital to preparing a highly-skilled workforce, as Amanda suggests, simply being proficient in one's content area is not sufficient for teaching in diverse settings (Gay, 2002; McConnell, Parker, & Eberhardt, 2013; Wang, 2013). Brooke and Marilyn similarly note that using CPSP to discuss human diversity at the beginning of the school year would be valuable whether it was used in a history or a foreign language classroom.

Major Theme Summary

This theme presented narratives related to various applications and strategies for using science to discuss human diversity in education. Overall, the responses support the notion that CPSP strategies are valuable for TEPs and K-12 settings in part because of the cross-discipline accessibility of CPSP and more generally the interdisciplinary nature of education. They also suggest that rather than impinging on 'non-science' teachers, incorporating CPSP strategies supports the differentiated learning for both students and teachers. And further, that its application in diverse classrooms use may also promote responsive teaching. Though, similar to her earlier comments about apprehension,

Sophia's remarks suggest that applying CPSP strategies is contingent on teachers' willingness to respond to the needs of their students.

Summary

This chapter presented the findings from the analysis of interviews conducted with 10 PSTs and 2 instructors to understand the potential utility and impact of using science to teach about diversity (CPSP) in teacher education programs (TEPs). Participant narratives suggest that much can be learned about human diversity through science, including insights and strategies for cultivating more inclusive learning environments, both in TEPs and in their future careers as educational professionals. In spite of the apparent challenges that also emerged from the analysis, the overall tenor of the themes similarly echo the utility of a scientific lens for understanding human diversity. Participants point to various applications of CPSP which deploys scientific inquiry and scientific knowledge to facilitate understandings of race, ethnicity and culture. In this way, the narratives presented in this chapter support the premise of this study to determine the utility of science for teaching about human diversity in TEPs, and to provide PSTs with related insights that can inform their future practice in positive and inclusive ways. The next chapter discusses findings presented above using a critical postmodern framework of science, diversity and education.

CHAPTER V: DISCUSSION OF FINDINGS

Previous chapters outlined the significance of the study, situated this research among relevant literature, described the research design, and presented the findings. This fifth and final chapter discusses the findings using a critical postmodern framework of science, diversity and education. The research questions for this study are: 1) What is the role of science in teaching about diversity to undergraduate preservice teachers at an urban research university in the Southeastern United States? 2) How might this approach impact preservice teachers across disciplines in terms of raising greater critical awareness and influencing inclusive classroom practices?

The chapter begins with a discussion of the theoretical framework which is then used to discuss the major themes and subthemes of the study. The major themes were: Critical Challenges and Sociocultural Dissonance; "Big Picture" Understandings of Race, Ethnicity, and Culture; Racial Anxiety and Apprehension versus Meaningful Dialogue; and Application, Strategies, and Impacts. Findings of the study are also connected to critical postmodern science (pedagogy) which serves as both the theoretical lens and method of investigative inquiry and instruction.

Theoretical Framework Revisited

This section revisits the study's theoretical foundation which merges critical social theory and postmodern social theory to unveil oppressions and unexamined truth claims in schools and society. The result of this convergence is a critical postmodern framework of science, diversity and education applied as a pedagogical strategy to teach

about human diversity; i.e., critical postmodern science pedagogy (CPSP). With respect to its focus on human emancipation and decentering absolutes, this composite framework stands as a critique not only of social and institutional oppressions but of any abuses levied in the name of science. Furthermore, when applied as a pedagogical strategy, CPSP becomes an incisive tool for understanding race, ethnicity and culture in ways that support responsive and egalitarian teaching.

The critical theory underpinnings of this framework serve as an investigative tool for questioning sociocultural patterns and assumptions tethered to societal prevalence rather than critiques of their effects. One effect of the prevalence of these often unexamined patterns, is the tendency toward exclusion of those whose appearance and/or values do not align with the dominant or hegemonic class, which remains anchored in Eurocentric cultural values and ideologies at the expense of nonwhites. The theoretical perspective of postmodernism rejects and disbands grand narratives or absolutes of any kind (Lyotard, 1984). In this way, a postmodern perspective offers a disconnected view of sociocultural phenomena and offers insights relative to their social and historical loci; though, not in search of truth, as such. Rather, when used toward egalitarian ends, postmodern social theory allows for an ‘empathic detattchment’ from which those things presumed to be true can be surveyed and then deconstructed. Not entirely divorced from the self-assigned task of critical theory to more directly upend social institutions that perpetuate the objectification and subjugation of the individual, a postmodern perspective is concerned with decentering the toxic network of intersecting oppressions from within the very structures that confine freedom itself by reconstituting the intents and functions of social discourse and action (Collins, 2000; hooks, 1990; Horkheimer & Adorno, 1972).

Critical theory's macrosocial view of society levies disarming attacks on overtly oppressive discourses and tactics, and disinters those that remain hidden. The goal of this metaphysical battle is to empower and transform the individual from Object to Agent of change, such that they might escape the shackles of false consciousness and restrictive banalities of hegemonic discourse that govern social action, thereby freeing oneself from the alienation therein (Gramsci, 1971; Horkheimer, 1982; Marcuse, 2001). A postmodern approach, however, views such attempts to critique *and* escape material conditions using normative analyses as cognitive futility. For, as Lorde (1984) put it, "the master's tools will never dismantle the master's house"; i.e., "What does it mean when the tools of a racist patriarchy are used to examine the fruits of that same patriarchy? It means that only the most narrow perimeters of change are possible and allowable" (pp. 110-112). A postmodern perspective seeks instead to unravel, de/construct and re/arrange these discursive formations, thus providing more nuanced understandings of the complex interplay between truth and power (Derrida, 1978; Foucault, 1980). And yet, without strong moorings in criticality and grounded understandings of the social world, which critical theory provides, in its opposition to grand narratives, postmodern theory risks dissolution into fantasy or perverse relativities of morality (Baudrillard, 1994; Lyotard, 1984; Steinberg & Kincheloe, 2010).

Such is the intersection and 'synergistic' relationship between critical and postmodern theory as it is used in this study (Steinberg & Kincheloe, 2010). The strength, then, of a critical postmodern framework of science, diversity and education rests in the collective ability of these two theoretical perspectives to detect, confront, disassemble and then re/construct (oppressive) discourses and conditions and thereby provide

enriched understandings of the world which can be used to confront illusive truth claims and false consciousness on material as well as conceptual levels in schools and society, such that one might reclaim their 'ontological vocation' of human agency and liberation (Freire, 1970; Horkheimer, 1982; Marcuse, 2001). A critical postmodern science theoretical framework thus becomes an important lens for analyzing the study's findings.

Critical Postmodern Science Analysis of Findings

This section discusses the findings presented in chapter four in relation to the critical postmodern framework and CPSP instructional method.

Critical Challenges and Sociocultural Dissonance

As mentioned in previous chapters, due to an increased number of science, technology, engineering and mathematics (STEM) professions over the last several decades and the current lack of qualified individuals to meet this demand, TEPs have become an integral nexus for preparing a diverse and highly-skilled workforce to support an eminent shift to a technically advanced knowledge-based economy in the 21st century (Cochran-Smith & Zeichner, 2009; Darling-Hammond, 2010; Gordon, 2009; NRC, 2007a, NRC, 2007b; Riegle-Crumb & King, 2010; Wang, 2013). Also mentioned was that while student populations across the country grow increasingly diverse, approximately 83 percent of their teachers are white, and 76 percent are female (NCES, 2013b; Swartz, 2003). However, as CPSP helps demonstrate, this largely 'white, monolingual, middle-class, female' cohort, alone, is not the issue (Banks & Banks, 2004; Brown, 2007; Milner, 2006, p. 344). Rather, as participant narratives in the *Critical Challenges and Sociocultural Dissonance* theme indicated, it is a troubling combination of social inequalities that pervade, especially, underserved schools and communities

comprised of racial and ethnic minorities, and the perpetuation of which through unexamined hegemonic cultural values transmitted through social institutional channels (Delpit, 2006; Delpit & Dowdy, 2002; Gay, 2002, 2010; Howard, 2006). This was evident in student responses related to several of the supporting concepts for this theme, including influential factors such as familial influences and cultural exposure, sociocultural influences and exposure to science, as well as religious beliefs. Marilyn's and Angela's respective accounts of the contemporaneity of racial discrimination in the South help illustrate this point. Marilyn, a native of Orange County, California stated:

> Truth be told, I never heard anybody say the "N-word" out loud until I moved to [this state]. People just dropped it in the conversation. I literally cannot even say that word out loud. I can't even believe - It took me off guard.
>
> Anyway, it's been a real eye-opener living in the South. People don't think that - when we go back to DC and tell people the things that people say, and they're like "It's not like that anymore." I'm like, "This happened last week."

Angela was born and raised in the South. Growing up, she shared her parents "very narrow-minded" views of diversity and "took a lot of what [her] parents said and used that as judgment toward people until [she] got to know them." It is clear that Angela learned prejudice at home, and from the people she trusts most. Interestingly, Marilyn discussed similar learned behaviors that provoked her fear of African Americans that she maintained into adulthood:

> My grandparents had owned that apartment building in Compton, and then they started building public housing in Compton. My grandparents sold their building because of what was happening. They must have been talking about what was happening to that neighborhood and stuff and blaming it on black people. I was picking up on that…
>
> I grew up thinking that I didn't have any racial bias against African-American people until I moved to D.C., and I realized that I had a fear when I saw African-American people. I recognized it. It took me a while to recognize it, but I didn't

> realize I had it until I spent time with African-American people. Then I had to be like, "Okay, you're being stupid. This is ridiculous."

As narratives in chapter four suggest, although some of the participants' views have since changed due to increased cultural exposure, and while the CPSP approach in this study appeared to allay some discomfort associated with discussing issues of race, Angela remains "nervous about saying or presenting something in the wrong way" in her future English classes while Marilyn is apprehensive because "some kid might take something wrong" that she said. One implication is that PSTs from the East to the West Coast of the U.S. may bring similar, culturally embedded experiences into the classroom, but perhaps without the necessary critical awareness or methods to reconcile static, sociocultural ideologies with the desire for personal growth.

From a critical postmodern perspective, these and related comments reflect an increased sociocultural dissonance beckoned by a rapidly changing demographic landscape and anachronistic views of race imparted by family, or what Popper (2002) describes as a conflict between 'conviction' and 'inter-subjective testing.' However, it would seem that through cultural exposure and increased awareness, both Marilyn and Angela were able to confront truth claims about racial categories presented to them as absolute, and continue to replace such ideas with enlightened understandings of human diversity. Thus, in line with the literature on teacher education and the CPSP framework, the intersection of increased diversity in schools and society, cultural mismatches between students and teachers along with unexamined truth claims borne out of dominant cultural values, rightfully remain one of the foremost concerns in teacher education (Howard, 2006; Milner, 2006). Further suggested, is that in the absence of critical awareness of human diversity or tools, such as CPSP, with which to confront misguided

ideological convictions, many PSTs will indeed enter diverse classrooms unprepared to address some of the issues they are certain to face in the years to come (Cho & DeCastro-Ambrosetti, 2005; Howard, 2006; Ladson-Billings, 2000; Milner, 2006; Swartz, 2003).

"Big Picture" Understandings of Race, Ethnicity, and Culture

In addition to contextualizing the critical challenges above, participants also noted that applications of science to understand both the natural and the social world facilitates *"Big Picture" Understandings of Race, Ethnicity, and Culture*. As mentioned in the previous chapter, the broad notion of 'understanding' emerged from many of the narratives, as well as questionnaires, discussions, and notes used in this study as a common thread among the other concepts. This theme includes participant responses regarding insights afforded by science and scientific inquiry about natural and social phenomena that inform deeper understandings of race, ethnicity and culture. Participant discussions and applications of scientific concepts that facilitated such understandings was a promising aspect of the study.

As mentioned in previous chapters, starting with the premise of a unified but shifting network of patterns that can be understood through systematic study, (natural) science involves attempts to "figure out how the world works by making careful observation and trying to make sense of those observations" (AAAS, 1993, 2010, p. 5). This suggests that similar applications of scientific information can assist in understanding, though not fully explain, social phenomena. The larger implication, then, is that applications of science raise important questions about the social world. For example, the oldest human jawbone fossil (~2.8 million years old) was recently discovered in Ethiopia by a research team from Arizona State University. And while

older fossils have been found that also link the first humans to an African origin, such as *Australopithecus afarensis*, better known as 'Lucy' (~3.2 million years old), and *Ardipithecus ramidus*, better known as 'Ardi' (~4.4 million years old), the significance of this find is that it is from the Homo genus, the next closest link to modern humans, Homo sapiens (sapiens), and thus, fills a 400,000 year gap that helps explain human evolution and migration (CNN, 2015).

Relatedly, and similar to the melanin dosage test proposed Diop (1974), an analysis of soft tissues from mummified remains dating back to approximately 1550 – 1080 BCE, revealed that the "basal epithelial cells were packed with melanin as expected for specimens of Negroid origin" (Mekota & Vermehren, 2005, p. 9). Epithlial cells form tightly-packed membranes that help protect the body from its surroundings, and their study has provided insights regarding the heterogeneity of specific types of cancer (Wang et al., 2013). In addition to their significance for understanding the natural world. such scientific discoveries raise social (as well as cultural) questions that may challenge oppositional beliefs regarding a common human origin in Africa as well as biological evolution. However, a CPSP lens reveals how these findings and context promote broader views of the natural and social worlds, and thus, deeper understandings of human diversity.

In the current study, several participants indicated that science provided a lens for seeing a bigger picture of the world that included individuals from all racial and ethnic backgrounds. Some attributed this expanded perspective to scientific evidence and data presented in the class discussion to demonstrate the extent to which all humans are similar. For instance, that each human shares 99.9 percent of their genetic makeup with

all other humans. The remaining 0.01 percent representing the phenotypic, or external, expressions of genetic coding, such as the melanin content in one's skin which is observed as skin color. Students were also presented with further explanations of how variations in skin color and other external features were the result of adaptations to the natural environment over time as well as one's proximity to the equator, where the sun's ultraviolet radiation is most intense, which helps explain the variation in color (i.e., darker skin protects against harmful UVB rays).

Some participants were aware that there was such a small difference between humans or other aspects of biology, geography and anthropology (and sociology) presented in class, others were hearing this information for the first time. However, all participants were able to make broader connections between the natural and social world as a result of CPSP and suggested that such knowledge helped put into perspective not only that humans are similar, but that the conflation of race and biology, then, must be a socially constructed idea, as Mark previously noted, "I'd say the most obvious point would be that science disproves the idea of race - that it's a social construct." Mark's comments reflect the notion that race is a social rather than natural (biological) phenomenon. In addition, such knowledge facilitates understandings and evokes questions regarding the realities of social stratification on the basis of racial categories. One connection of this theme to the CPSP framework is evidenced by the application of science – an almost exclusively positivist, Eurocentric enterprise traditionally used against those who did not resemble an 'ideal type' of human promulgated by dominant class ideologies – to deconstruct and be recast as a method to help liberate from racial discrimination both the oppressed and the oppressors (Freire, 1970; Weber, 2009).

In this sense, culture becomes a very important aspect of one's ethnicity. Culture entails all of the social norms, values, beliefs, expressions, and rituals that can be identified with a particular social group. This suggests that while race is simply a social construction that tells us how a person looks, culture serves as the real currency that makes up an individual's identity. Critical postmodern science (pedagogy) thus becomes and important lens for analyzing the findings of the study. Further, due to the sociocultural dissonance that discussing or confronting race-related issues often carries with it, the participants expressed that using science to understand and discuss human diversity can help reduce racial anxiety and encourage more meaningful dialogue about such issues.

Racial Anxiety and Apprehension versus Meaningful Dialogue

Brooke noted:

> I feel confident in the fact that I will be able to treat everybody in the classroom equally, but it does make me nervous to go into a school where I might be the minority, and to have students looking at me, and judging me, and me being on the reverse side.

Brooke raises an important point regarding what happens when the teacher becomes the minority in public schools. This can create a lot of anxiety and apprehension in teachers and students. Given that 83 percent of the teachers in this country are white, Brooke, who is a white female, will experience a racial and cultural mismatch that many teachers struggle with in the classroom. Thus, it is crucial that PSTs have a strong foundation in multicultural and diversity perspectives in education. In this way, CPSP (strategies) plays an important role in opening up the dialogue on a very sensitive yet important topic in teacher education programs. The participants in this study expressed how CPSP helped broaden their views and deepen their understandings of human diversity in ways that support positive and inclusive strategies and classroom practices.

Similarly, the literature on critical pedagogy and teaching and learning science, conveys the importance of authentic and democratic dialogue for student achievement (Atwater, 1996b; Barton & McLaren, 2001; Basu & Barton, 2010). This research demonstrates the possibilities of science in education to assist in one's personal transformation by developing the ability to locate and confront social injustice in ways that empower, in this case, students and teachers to become change agents in schools and society (Bandura, 1989; Freire, 1970; Giroux, 1988, 2005; Kanpol, 1992; Kanpol & McLaren, 1995b; McLaren, 1999). In this way, scientific inquiry and investigations become a tool for disrupting oppressive discourse in schools and society (Atwater, 1996b; Barton & McLaren, 2001; Basu & Barton, 2010).

Akin to CPSP, the literature on CRP and science also underscores the need for greater accessibility to science for students from diverse backgrounds (Aikenhead, 1996, 1997; Atwater, 1996b, 2010; Gay, 2002; Hickling-Hudson, 2003; Jegede & Aikenhead, 1999; Nieto & Bode, 2012). This aspect of research on critical and culturally responsive science pedagogy also points to the need for awareness of dominant cultural values and hegemonic discourses embedded in education, including "the selective inclusion and exclusion of material" in the curriculum, high-stakes accountability measures that disproportionately affect urban schools attended by racial and ethnic minorities, as well as the increasing presence of corporate privatization (Asante, 1991; Barton & McLaren, 2001; Hickling-Hudson, 2003; Kumashiro, 2001, p. 4; Lipman, 2000, 2002, 2004; McLaren & Farahmandpur, 2001). In helping students restore and maintain their humanity, critical and culturally responsive science pedagogies provide meaningful entry points for scientific inquiry for all students (Irvine, 1992; Ladson-Billings, 1995b; Nola

& Irzık, 2005). For CPSP, these approaches represent powerful additives, in terms of leveraging the investigative power of science for teaching about human diversity.

CPSP helps open dialogue on sensitive topics surrounding race, ethnicity and culture (REC) in the classroom without essentializing or marginalizing any particular social group. Using science as the basis of analysis helps decenter oppressive discourses in education and also creates a safe space for students to discuss human diversity as being along a continuum that begins in East Africa. The scientific acknowledgment that all human beings share 99.9 percent of the same DNA debunks racial, cultural, gender, and religious superiority claims across the family tree. This is an important issue, where in other forms of teaching about diversity one can go through the process but remain racist, sexist and/or a religious fundamentalist. In light of these important outcomes, teacher education programs must respond by providing PSTs appropriate tools and strategies to confront such issues at a deeper level than those currently provided.

Applications, Strategies, and Impacts

Another common view among participants was that a scientific perspective is a valuable contribution in teacher education as well as K-12 settings. Such applications of science beyond the science classroom help PSTs develop deeper understandings of human diversity regardless of the subject area. This awareness can help create an awareness regarding issues that can disproportionally affect minority groups namely, discrimination and teacher bias. In this sense, teachers' understanding of issues surrounding diverse learners becomes crucial to student outcomes. Therefore, teachers should be cognizant of the strategies they can use to foster diversity and inclusion. As Brooke explains:

> I think no matter what subject you're teaching, it's important to bring up on the first day of class that everybody's going to be treated with respect and everybody's equal. And you could definitely bring up that scientific point of view to show that everybody is the same.

Brooke's comment points to the importance of a scientific perspective of diversity. She mentions that a teacher can use a scientific perspective to show students that beyond race everyone is the same. As such, CPSP and other multicultural and diversity approaches become crucial for effective teaching.

Banks and Banks argue that multiculturalism and multicultural education are a rejoinder to increased cultural intersections and the subsequent need for "gender, ethnic, race, and cultural diversity of a pluralistic society [to be] reflected in all of the institutionalized structures of educational institutions" (2010, p. 447) through concerted efforts to incorporate the "content, concepts, principles, theories, and paradigms from history, the social and behavioral sciences, and particularly from ethnic students and women's studies" (2004, p. xii). These and other conceptual understandings are integral to addressing educational inequalities that most often affect racial and ethnic minorities. Mediating these disparities might include adapting a curriculum that highlight the achievements and language of nonwhites (Banks, 1993a, 1993b; Banks & Banks, 2010; May, 1999; Sharpe, 2005).

Increasingly, multicultural education has drawn from critical and culturally responsive approaches to help support and strengthen this mission, and to address the complex interplay of science, society and diversity (Atwater, 1996a; Cochran-Smith & Zeichner, 2009; Emdin, 2008a; Gay, 2002; King, 1991; Milner, 2006). And because science is still dominated by a male Eurocentric perspective, this literature also addresses the need for a diverse and highly-skilled workforce through conceptual and pedagogical

methods such as critical pedagogy, CRP, and multicultural science education (MSE) (Atwater, 1989, 1996a, 2011; Barton & McLaren, 2001; Basu & Barton, 2010; Hodson, 1993, 1999; Hodson & Dennick, 1994). While each of these areas of research have made significant contributions to education and, indeed, to this study, the implications of using science to teach about diversity is virtually absent from the literature. As such, this study is so positioned to contribute to a growing body of knowledge on diversity in education through critical postmodern science pedagogy.

In a related a literature, CRP, which is itself an extension of critical pedagogy, addresses social justice and inclusion by attending to students' ethnoracial, cultural and linguistic differences in the learning process. Not unlike its critical counterpart, when applied to science CRP demonstrates the importance of connecting subject area content to "the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" (Gay, 2002, p. 106). However, critics such as Bowers (2005), Gur-Ze'ev (1998), Tubbs (2005) and Rømer (2011) claim that critical and culturally responsive pedagogical approaches are little more than utopian and positivist-leaning variations of neoliberal practices that inherently seek to normalize education such that they conform to universal truths and resist self-examination due to a fixation on material forms of oppression and willful ignorance of abstract consciousness. In this sense, critical science pedagogy may be mis/construed as a harbinger of the very repression it seeks to subvert. However, one implication of CPSP is that it can avoid incapacitating the transformative potential of students and practitioners and create more reflective and responsive perspectives in education in that it attends to both the material and the abstract (Ladson-Billings, 1995a; Laughter & Adams, 2012; Mensah, 2011).

Likewise, with the goal of empowerment, CRP and science views students as agents rather than victims. As such, it seeks to assist students in the personal development of a critical consciousness with which to confront social disparities in their home communities (Barton, 2003; Barton & Berchini, 2013; Ladson-Billings, 1995a, 1998; Lee, 2001). This research suggests that a relevant and responsive approach to teaching science supports high academic achievement regardless of the subject matter or a student's cultural background (Gay, 2002; Ladson-Billings, 2009; Lee, 2001; Lee & Buxton, 2008; Lee & Fradd, 1998). Relating to students' culture, the use of language in schools becomes central to teacher pedagogy and student outcomes.

In examining the role of language in science, Brown (2006) discovered that students from diverse backgrounds found it difficult to reconcile their personal identities in the realm of politicized public and scientific discourse. Addressing this challenge, Emdin (2008a) used hip-hop music and popular culture as a political act to teach science to a diverse group of students in an urban setting. The students not only added the contextualized voice that Brown (2006) observed was lacking, but in the space created by this critical approach were able to reclaim their humanity by way of inclusion in contemporary scientific discourse (Emdin, 2007, 2008a). Similarly, Buxton (2010) employed a critical and political approach to science with diverse urban students by having them compare and contrast the quality, distribution, and consumption of natural resources in both poor and affluent areas surrounding their local community to raise student awareness of social inequalities. These studies suggest that critical science pedagogy is one way to raise awareness of political issues within and beyond the science classroom. And while these critical perspectives and macrosocial inquiries involving

science may indeed contribute to the development of anti-essentialist, antiracist education, their impact is often moderated by the challenge of consistent application (Atwater, 2011; May, 1999; McLaren & Torres, 1999).

In this way, CPSP has the potential to re/locate and de/construct unexamined truth claims in schools and society, and particularly those regarding the intelligence and cognitive ability of racial and ethnic minority students (Marks, 1995, 2008; Wiggan, 2007). Drawing from a critical postmodern perspective of science, this study aimed to unveil and decenter oppressive hegemonic discourses by re/framing science as a pedagogical tool and instrument to bring about greater awareness surrounding human diversity and issues of difference. Based on the findings of this study, the following recommendations are being made.

Recommendations

The participants suggest that TEPs should have either a standalone course on using science to address diversity, or include it as a component of an existing diversity-related course. While a few students suggested that CPSP should be part of an existing course, the majority of the participants believe that it would be most effective as a specific course in TEPs. Relating to the issue of having a prescribed course using CPSP in the TEP, some participants also thought that it would be beneficial to have professional development training for in-service teachers on this topic. This would entail having outreach and support or in-service public school teachers to ensure the effective implementation of CPSP. Administrators, teachers, students, and potentially parents could gain from the strategies and perspective that CPSP offers.

Since CPSP is a new framework, the body of scholarship on this topic should be supported by additional studies. While critical pedagogy, culturally responsive, and multicultural frameworks have provided important insights regarding diversity in teaching diverse learners, CPSP extends beyond this by using science to contextualize and critique social, cultural, historical and contemporary processes toward deeper and more nuanced understandings of human diversity in society. Understanding the origins of the human family tree in Africa, and the development of different cultures and cultural narratives about the world in this way can help to decenter essentialist, racist, sexist and/or religious fundamentalist discourse.

Another implication of the findings of the study is that CPSP could potentially be offered as a certificate program that is open to all majors. Such a program would provide in-depth training and credentialing documentation. Based on the findings of the study, the recommendations are aimed toward colleges of education, preservice, in-service teachers, and K-12 education.

Limitations

The study examined one case of three undergraduate PST education courses bounded to one institution, to determine the role of science in teaching about diversity in teacher education programs (Creswell, 1998). Given the inherent currency of this topic about which little is known, the findings may be applicable beyond the boundaries of the present study. These limitations do not impinge on the quality of the study or its ability to respond to the research questions. Instead, by utilizing a single unit of analysis and small sample size, the design can be easily replicated and/or expanded. Moreover, this study

could lay important groundwork for future research, including alternative applications of CPSP in professional development, curriculum development, and educational policy.

Recommendations for Future Research

Future research should be conducted using CPSP in K-12 settings as well as in higher education courses (education and non-education courses). In addition, further research should be conducted to determine the extent to which CPSP might inform administrative practices and educational policy.

Summary

In conclusion, this study investigated the role of science in teaching about human diversity, which places science at the center of inquiry. The research explored issues of science and diversity in a 21st century context. Given the profound implications of increasing diversity in schools and the majority white teacher workforce, there is a growing need to prepare teachers to understand and teach about diversity. As such, this study is significant in that it explores the utility of science as a transdisciplinary method for teaching diversity to preservice teachers. CPSP has the potential for raising greater awareness about issues of race and ethnicity in schools and society. The findings of the study suggests that using science to discuss diversity, can indeed, influence positive and inclusive teacher practices which promote greater awareness and effective classroom practices in diverse settings.

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APPENDIX A: RECRUITMENT SCRIPTS

The following recruitment scripts were attached to emails sent to the instructors of the selected courses to solicit theirs and their students' participation in the study. This information was also included with the online questionnaire.

APPENDIX A-1: PRESERVICE TEACHER RECRUITMENT SCRIPT

[Month Day], 2014

Dear [TU Student]:

Hello, my name is Anthony Ash. I am a graduate student at TU in the Department of Middle, Secondary, and K-12 Education. I am conducting research on undergraduate teacher education diversity courses, and I am inviting you to participate because you are a student in one such course in the Teacher Education Program (TEP) at TU.

Participation in this research includes completing an online questionnaire regarding your attitudes about diversity as well as how diversity issues are addressed in TEPs, which will take approximately 15–20 minutes, followed by a 45–60 minute interview (either by phone, Google Voice, Skype, or in-person). Part of this study also involves classroom observations and an instructional intervention that would take one or two class periods, and one follow-up interview. The research will take place primarily during the months of November 2014 to March 2015. Your total time commitment will be between 2–3 hours, which includes the completion time for two (2) questionnaires, two (2) interviews, and the instructional intervention over one or two class periods. However, this would take place during the normal class time.

If you have any questions or would like to participate in the research, I can be reached at [phone number] or [email address].

Sincerely,

Anthony Ash

APPENDIX A-2: PROFESSOR RECRUITMENT SCRIPT

[Month Day], 2014

Dear [Faculty Member]:

Hello, my name is Anthony Ash. I am a doctoral student at TU in the Department of Middle, Secondary, and K-12 Education. I am conducting research on undergraduate teacher education diversity courses, and I am inviting you to participate because you are the instructor of one such course in the Teacher Education Program (TEP) at TU.

The study will be conducted in four phases. Collectively, it will require an estimated 2-3 hours of your time. In the first phase, which will take 15-20 minutes to complete, an online questionnaire will be administered that captures demographic information and your views of diversity. Classroom observations will begin during this phase. In the second phase, you will be interviewed for approximately 45-60 minutes at an agreed upon time, either by phone, electronically via Skype or Google Voice, or in person.

The third phase consists of researcher-led class discussion(s) about human diversity, which would take one or two class periods. The fourth phase involves the second questionnaire and a follow-up interview after the discussion(s), which will revisit some of the questions from the first interview. Interviews will be audio recorded and will include questions about your views of diversity in schools and society. The recordings will be transcribed by the researcher. The study will take place from November 2014 to March 2015.

If you would like to participate in this study, please respond with a few possible dates for the in-class discussion. I will follow up to confirm and to send two links to the questionnaire (one for you and one for your students). The link to the student questionnaire can either be emailed to them directly and/or posted on Moodle.

Should you have any general questions about the study, please feel free to contact me. I can be reached at [email address] or [phone number]. Your support would be greatly appreciated.

Kind Regards,
Anthony Ash

APPENDIX B: INFORMED CONSENT LETTERS

The following informed consent letters were made available on the questionnaire and as a printable alternative to the online version.

APPENDIX B-1: PRESERVICE TEACHER INFORMED CONSENT LETTER

PRESERVICE TEACHER CONSENT TO PARTICIPATE IN A RESEARCH STUDY

"Science, Diversity, and Teacher Education"

You are being asked to participate in a research study, "Science, Diversity, and Teacher Education." The purpose of this research study is to explore how and why science might be used in Teacher Education Programs (TEPs) as a method to teach pre-service educators about diversity. Please read the information carefully. At the end, you will be asked to sign this document if you agree to participate in the study.

Anthony Ash, a TU PhD student in the Department of Middle, Secondary, and K-12 Education (MDSK) will be conducting this research project. Drs. Greg Wiggan and Charles B. Hutchison, Associate Professors in the MDSK Department, will supervise the study.

You have been contacted about this study because you are enrolled in or teach MDSK 2100 in the College of Education at TU. There will be an anticipated total of 33 participants in the study, including three (3) instructors and thirty (30) pre-service teacher candidates chosen randomly from those who agree to participate in the study.

The study will be conducted in four phases; collectively, it will require an estimated 2–3 hours of your time. In the first phase, you will complete a 10-20 minute online questionnaire that captures demographic information and general views of diversity. In the second phase, interviews will be scheduled and classroom observations will take place.

The third phase consists of an in-class discussion about human diversity, which will led by the researcher in your classroom during your regularly scheduled meeting time. A follow-up interview will be conducted after the discussion and will ask similar questions. Interviews will be audio recorded and will consist of questions about your views of science and diversity in schools and society. The audio recordings will be transcribed and then analyzed by the researcher.

It is possible that talking about diversity issues that involve race, ethnicity, and culture could make you feel uncomfortable. You are welcome to skip any questions that make you feel uncomfortable, and you may also stop the interview at any time.

However, some people find talking about diversity issues to be helpful. A possible benefit of this study is that it may raise critical awareness of ethnic and racial human differences, and inform pedagogical practice in positive and inclusive ways when teaching individuals from diverse backgrounds.

The researcher will make every effort to protect your privacy. All your responses to the interview questions will be kept confidential. The digital audio recording files will be kept on a password protected computer in a password protected folder. The recordings will not be stored on a public network folder. The recordings will be coded using your TU email address rather than your name to keep all information linked. Once all questionnaires and interviews are completed, email addresses will be deleted and replaced with a randomly generated number. After the audio recording is transcribed, it will be destroyed. The transcriptions will contain no identifying information. During the study, all transcription materials will be stored on a password protected

computer and accessed only by the researcher. When the results of this study are released, participants will be referred to by pseudonyms rather than their real names.

The decision to participate in this study is completely up to you. You will not be treated any differently if you decide not to be in this study. If you decide to be in the study, you have the right to withdraw from the study at any time.

TU wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at [phone number] if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact Anthony Ash [phone number], [email address].

This form was approved for use on *March 27, 2014* for a period of one (1) year.

I have read the information in this consent form. I have had the chance to ask questions about this study, and those questions have been answered to my satisfaction. I am at least 18 years of age, and I agree to participate in this research project. I understand that I will receive a copy of this form after it has been signed by me and the principal investigator of this research study.

_____	_____	_____
Printed name of participant	Signature of participant	Date

_____
Person obtaining consent

APPENDIX C: QUESTIONNAIRES

The following questionnaires were administered online and were used to capture demographic information of participants and their views about student diversity and the potential role of science in this regard. The questionnaires also served as a means to schedule interviews for those who agreed to participate in that component of the study.

APPENDIX C-1: PRESERVICE TEACHER QUESTIONNAIRE

Science, Diversity, and Teacher Education [Preservice Teacher] Online Questionnaire

Welcome to "Science, Diversity, and Teacher Education," a study that explores the role of science in Teacher Education Programs (TEPs) as a method to teach pre-service educators about diversity. Before taking part in this study please read the consent form below and click "I agree" at the bottom of the consent form if you understand the statements and freely consent to participate in the study.

INFORMED CONSENT for PRESERVICE TEACHERS

You are being asked to participate in a research study, "Science, Diversity, and Teacher Education." The purpose of this research study is to explore how and why science might be used in Teacher Education Programs (TEPs) as a method to teach pre-service educators about diversity. Please read the information carefully. At the end, you will be asked to sign this document if you agree to participate in the study.

Anthony Ash, a TU PhD student in the Department of Middle, Secondary, and K-12 Education (MDSK) will be conducting this research project. Drs. Greg Wiggan and Charles B. Hutchison, Associate Professors in the MDSK Department, will supervise the study.

You have been contacted about this study because you are enrolled in MDSK 2100 in the College of Education at TU. There will be an anticipated total of 33 participants in the study, including three (3) instructors and thirty (30) pre-service teacher candidates chosen randomly from those who agree to participate in the study.

The study will be conducted in four phases; collectively, it will require an estimated 2–3 hours of your time. In the first phase, you will complete a 10-20 minute online questionnaire that captures demographic information and general views of diversity. In the second phase, interviews will be scheduled and classroom observations will take place.

The third phase consists of an in-class discussion about human diversity, which will led by the researcher in your classroom during your regularly scheduled meeting time. A follow-up interview will be conducted after the discussion and will ask similar questions. Interviews will be audio recorded and will consist of questions about your views of science and diversity in schools and society. The audio recordings will be transcribed and then analyzed by the researcher.

It is possible that talking about diversity issues that involve race, ethnicity, and culture could make you feel uncomfortable. You are welcome to skip any questions that make you feel uncomfortable, and you may also stop the interview at any time.

However, some people find talking about diversity issues to be helpful. A possible benefit of this study is that it may raise critical awareness of ethnic and racial human differences, and inform pedagogical practice in positive and inclusive ways when teaching individuals from diverse backgrounds.

The researcher will make every effort to protect your privacy. All your responses to the interview questions will be kept confidential. The digital audio recording files will be kept on a password protected computer in a password protected folder. The recordings will not be stored on a public network folder. The recordings will be coded using your TU email address rather than your name to keep all information linked. Once all questionnaires and interviews are completed, email addresses will be deleted and replaced with a randomly generated number. After the audio recording is transcribed, it will be destroyed. The transcriptions will contain no identifying

information. During the study, all transcription materials will be stored on a password protected computer and accessed only by the researcher. When the results of this study are released, participants will be referred to by pseudonyms rather than their real names.

The decision to participate in this study is completely up to you. You will not be treated any differently if you decide not to be in this study. If you decide to be in the study, you have the right to withdraw from the study at any time.

TU wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at [phone number] if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact Anthony Ash [phone number], [email address].

You may print a copy of this form. If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, select "I agree" to begin the questionnaire.

Do you wish to continue?

○ I agree

○ I do not agree

[Choosing "I agree" will direct the page to the following set of questions.
Choosing "I do not agree" will direct the page to the end of the form.]

GENERAL INFORMATION
Directions: Please select the appropriate response where required.

How old are you?
___ 18 ___19 ___20 ___21 ___22 ___23 ___24 ___25 ___26-29 ___30 or older

What is your sex?
___ Female ___ Male

Which of the following categories describes you?
Choose all that apply.
___ American Indian/Native American
___ Asian-American/Pacific Islander
___ Latino/a/Hispanic/Chicano/a
___ African-American/Black
___ White/European-American
___ Other: _____

What is your current grade level?
___ First year
___ Sophomore
___ Junior
___ Senior

If applicable, what is your current grade point average (GPA) at this institution?

Choose one. Course instructors should skip this question.
___ Below 2.5
___ 2.50 – 2.75
___ 2.75 – 3.00
___ 3.00 – 3.25
___ 3.25 – 3.50
___ Above 3.50

TEACHING ASPIRATIONS
In this section you will be asked a series of questions about where and to whom (what grade level) you anticipate teaching.

What was the zip code of your residence at the time of high school graduation?
Postal codes up to 9 characters long are accepted
_____

In what type of locale do you plan to teach?
Choose one.
___ Rural (pop. less than 25,000)
___ Urban (pop. less than 50,000)
___ Suburban (pop. between 25,000 and 50,000)
___ No preference

What grade level(s) do you wish to teach?
Check all that apply.
___ K-5
___ 6-8
___ 9-12
___ Higher education
___ Other: _____

SCIENCE, DIVERSITY, & TEACHER EDUCATION
In the following sections you will be asked a series of questions about science and diversity as it pertains to both your personal experiences as well as the teacher education program. The following definitions are provided for reference.

Science: The systematic process of trying to figure out how the world works by making careful observations and trying to make sense of those observations

Diversity: A group of people that include individuals from different ethnic and cultural groups that have distinct characteristics, qualities, or elements (Bennett, 1999)

Culture: The totality of socially transmitted behavior patterns, arts, beliefs, institutions, and all other products of human work and thought. These patterns, traits and products are considered the expression of a particular period, class, community, or population (Gay, 2010)

Ethnicity: A group of people sharing a common and distinctive racial, national, religious, linguistic, or cultural heritage (Banks, 1994)

Multiculturalism: A social or educational theory that encourages interest in many cultures within a society rather than in the mainstream culture (Banks, 1994)

Including English, how many languages do you speak fluently?
Choose one.
___ One
___ Two
___ Three
___ More than three

Did you ever receive free or reduced lunch during your K-12 schooling?
___ Yes ___ No

Would you consider your high school population ethnically diverse?
___ Yes ___ No

Would you consider the teaching staff at your high school population ethnically diverse?
___ Yes ___ No

Would you consider the community in which you were raised ethnically diverse?
___ Yes ___ No

How would you describe the student body at UNC Charlotte?
___ Primarily one racial group
___ Two or more racial groups
___ Many racial groups

How would you describe "student diversity?"
Please answer as fully as possible.

Diversity in Teacher Education
Please respond as fully as possible to the following questions about diversity and your experiences in the teacher education program (TEP).

In what ways has this TEP prepared you to teach in diverse settings?
Specifically, in terms of raising your awareness about diversity issues such as race, ethnicity, and culture through classroom discussions, activities, and assignments.

How is (would) student diversity be addressed in your classroom?

How confident are you in your ability to effectively teach racially, ethnically, and culturally diverse students?

How might using science to teach about diversity raise preservice teacher awareness about issues of race and ethnicity? In what ways could doing so inform their practice in positive and inclusive ways?

How might this approach impact teacher practice when teaching to diverse populations?

How might using science assist in preparing preservice teachers to address and/or take a stand for human rights and social justice issues?

INTERVIEW SCHEDULING

This section is to schedule the initial and follow-up interviews for the study. Each of the interviews will last approximately 45-60 minutes. Please identify a good day and time to conduct the interviews and your preferred method of communication.

Best day(s) for Interview
Choose all that apply.
___ Sunday ___ Monday ___ Tuesday ___ Wednesday ___ Thursday ___ Friday ___ Saturday

Best time(s) for Interviews
Choose all that apply.
___ Between 8am and 12pm
___ Between 12p and 4pm
___ Between 4pm and 8pm
___ No preference
___ Other: _____

What is your preferred method/technology for the interviews?
___ Phone
___ Google (Voice, Plus, or Hangouts)
___ Skype
___ In-person
___ No preference

Thank you for your participation in this study!

Reminder: Your participation is voluntary. Choosing not to participate will in no way adversely affect your relationship with TU, your instructors, or the researcher.

APPENDIX C-2: PROFESSOR TEACHER QUESTIONNAIRE

Science, Diversity, and Teacher Education [Professor] Online Questionnaire

Welcome to "Science, Diversity, and Teacher Education," a study that explores the role of science in Teacher Education Programs (TEPs) as a method to teach pre-service educators about diversity. Before taking part in this study please read the consent form below and click "I agree" at the bottom of the consent form if you understand the statements and freely consent to participate in the study.

INFORMED CONSENT for PROFESSORS

You are being asked to participate in a research study, "Science, Diversity, and Teacher Education." The purpose of this research study is to explore how and why science might be used in Teacher Education Programs (TEPs) as a method to teach pre-service educators about diversity. Please read the information carefully. At the end, you will be asked to sign this document if you agree to participate in the study.

Anthony Ash, a TU PhD student in the Department of Middle, Secondary, and K-12 Education (MDSK) will be conducting this research project. Drs. Greg Wiggan and Charles B. Hutchison, Associate Professors in the MDSK Department, will supervise the study.

You have been contacted about this study because you are and instructor in MDSK 2100 in the College of Education at TU. There will be an anticipated total of 33 participants in the study, including three (3) instructors and thirty (30) pre-service teacher candidates chosen randomly from those who agree to participate in the study.

The study will be conducted in four phases; collectively, it will require an estimated 2–3 hours of your time. In the first phase, you will complete a 10-20 minute online questionnaire that captures demographic information and general views of diversity. In the second phase, interviews will be scheduled and classroom observations will take place.

The third phase consists of attending an in-class discussion about human diversity, which will led by the researcher in your classroom during your regularly scheduled meeting time. A follow-up interview will be conducted after the discussion and will ask similar questions. Interviews will be audio recorded and will consist of questions about your views of diversity in schools and society. The audio recordings will be transcribed and then analyzed by the researcher.

It is possible that talking about diversity issues that involve race, ethnicity, and culture could make you feel uncomfortable. You are welcome to skip any questions that make you feel uncomfortable, and you may also stop the interview at any time.

Some people find talking about diversity issues to be helpful. A possible benefit of this study is that it may raise critical awareness of ethnic and racial human differences, and inform pedagogical practice in positive and inclusive ways to individuals from diverse backgrounds.

The researcher will make every effort to protect your privacy. All your responses to the interview questions will be kept confidential. The digital audio recording files will be kept on a password protected computer in a password protected folder. The recordings will not be stored on a public network folder. The recordings will be coded using your TU email address rather than your name to keep all information linked. Once all questionnaires and interviews are completed, email addresses will be deleted and replaced with a randomly generated number. After the audio recording is transcribed, it will be destroyed. The transcriptions will contain no identifying information. During the study, all transcription materials will be kept in a locked filing cabinet in

a locked office. When the results of this study are released, participants will be referred to by pseudonyms rather than their real names.

The decision to participate in this study is completely up to you. You will not be treated any differently if you decide not to be in this study. If you decide to be in the study, you have the right to withdraw from the study at any time.

TU wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at [phone number] if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact Anthony Ash [phone number], [email address].

You may print a copy of this form. If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, select "I agree" to begin the questionnaire.

Do you wish to continue?

○ I agree

○ I do not agree

[Choosing "I agree" will direct the page to the following set of questions.
Choosing "I do not agree" will direct the page to the end of the form.]

GENERAL INFORMATION

In this section you will be asked a series of general information questions as well as questions about your previous teaching experience. Please select the appropriate response where required.

What is your sex?
___ Female ___ Male

Which of the following categories describes you?
Choose all that apply.
___ American Indian/Native American
___ Asian-American/Pacific Islander
___ Latino/a/Hispanic/Chicano/a
___ African-American/Black
___ White/European-American
___ Other: _____

Please indicate the total number of years teaching with this institution:
___ Less than 1 year
___ 1 to 5 years
___ More than 5 years

Please indicate the total number of years teaching experience:
___ Less than 1 year
___ 1 to 5 years
___ More than 5 years

Teaching Experience

Which type of locale best describes where you've spent most of your teaching experience?
Choose one.
___ Rural (pop. less than 25,000)
___ Urban (pop. less than 50,000)
___ Suburban (pop. between 25,000 and 50,000)
___ No preference

What grade level(s) have you previously taught?
Check all that apply.
___ K-5
___ 6-8
___ 9-12
___ Higher education
___ Other: _____

SCIENCE, DIVERSITY, & TEACHER EDUCATION

In the following sections you will be asked a series of questions about science and diversity as it pertains to both your personal experiences as well as the teacher education program. The following definitions are provided for reference.

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Culture: The totality of socially transmitted behavior patterns, arts, beliefs, institutions, and all other products of human work and thought. These patterns, traits and products are considered the expression of a particular period, class, community, or population (Gay, 2010)

Ethnicity: A group of people sharing a common and distinctive racial, national, religious, linguistic, or cultural heritage (Banks, 1994)

Multiculturalism: A social or educational theory that encourages interest in many cultures within a society rather than in the mainstream culture (Banks, 1994)

Including English, how many languages do you speak fluently?
Choose one.
___ One
___ Two
___ Three
___ More than three

Did you ever receive free or reduced lunch during your K-12 schooling?
___ Yes ___ No

Would you consider your high school population ethnically diverse?
___ Yes ___ No

Would you consider the teaching staff at your high school population ethnically diverse?

___ Yes ___ No

Would you consider the community in which you were raised ethnically diverse?
___ Yes ___ No

How would you describe the student body at UNC Charlotte?
___ Primarily one racial group
___ Two or more racial groups
___ Many racial groups

How would you describe "student diversity?"
Please answer as fully as possible.

Diversity in Teacher Education
Please respond as fully as possible to the following questions about diversity and your experiences in the teacher education program (TEP).

In what ways has this TEP prepared your preservice teachers to teach in diverse settings?
Specifically in terms of raising awareness about diversity issues such as race, ethnicity, and culture through classroom discussions, activities, and assignments.

How is student diversity addressed in your classroom?

How confident are you in the ability of your preservice teachers to teach racially, ethnically, and culturally diverse students?

How might using science to teach about diversity raise preservice teacher awareness about issues of race and ethnicity? In what ways could doing so inform their practice in positive and inclusive ways?

How might this approach impact teacher practice when teaching to diverse populations?

How might using science assist in preparing preservice teachers to address and/or take a stand for human rights and social justice issues?

INTERVIEW SCHEDULING
This section is to schedule the initial and follow-up interviews for the study. Each of the interviews will last approximately 45-60 minutes. Please identify a good day and time to conduct the interviews and your preferred method of communication.

Best day(s) for Interview
Choose all that apply.
___ Sunday ___ Monday ___ Tuesday ___ Wednesday ___ Thursday ___ Friday ___ Saturday

Best time(s) for Interviews
Choose all that apply.
___ Between 8am and 12pm
___ Between 12p and 4pm
___ Between 4pm and 8pm
___ No preference
___ Other: _____

What is your preferred method/technology for the interviews?
___ Phone
___ Google (Voice, Plus, or Hangouts)
___ Skype
___ In-person
___ No preference

Thank you for your participation in this study!

Reminder: Your participation is voluntary. Choosing not to participate will in no way adversely affect your relationship with TU or the researcher.

APPENDIX D: GENERAL OBSERVATION PROTOCOL

Observation Protocol

Date: _____ Time: _____

Place: _____ Course ID: _____

Observation / Code	Reflection

APPENDIX E: INTERVIEW PROTOCOL

The semi-structured interview protocol in this section were used for preservice teachers and instructors of the courses selected for this study. Questions were tailored to participants accordingly during the interview process.

APPENDIX E: INTERVIEW PROTOCOL

SECTION I: ***Introduction and Warm-up***

- **Intro**: *Thank you….*
- Confirm the respondent's name; tell them it won't use again in order to assure anonymity.
- Remind participant: *This study is interested in the role of science in teaching about diversity.*
- ***Begin recording****…*
- Give participant a chance to ask questions about the study or the interview process.
- Get verbal consent: *Review informed consent*
- Mention the participants' number which will be randomly generated from emails provided in the questionnaire (i.e., you are participant #24245).

Warm-up Questions

- Tell me a little about where are you from. (*What it's like; people you grew up with, etc.*).
- What's your major?
- How far along are you?

SECTION II: ***Race, Culture and Education***

1. How would you describe your cultural background?
2. What has been most influential in shaping your views of human diversity, and more generally, people who are different from you?
3. Can you provide an example of a classroom experience where you were discussing racial/ethnic issues with a person you perceived to be different than you? (Good or bad).
    - Can you provide a specific example?
4. Describe your thoughts about teaching students who may be culturally different than you.
    - That is, how will student diversity be addressed in your classroom?
    - How confident are you in your ability to teach racially, ethnically, and culturally diverse students?
5. In your view, what effect does a child's cultural background have on his or her education?
    - What has informed your response?
6. Describe what is needed to be a successful teacher of students from diverse backgrounds… (*How did you arrive at this conclusion?*)

SECTION III: ***Science, Diversity and Education***

1. In what ways has science or scientific knowledge been influential in your life and understanding the world (e.g., how you live, work, play, learning, etc.)?
2. What can science or scientific knowledge tell us about race, ethnicity, and culture (if anything)?
    - What can science contribute to understanding race relations and multiculturalism in society?
    - What are your thoughts on science contributing to inclusive, pluralistic schools and society?
3. How might the use of science help PSTs better understand issues of racial and ethnic diversity?
    - In what ways could doing so inform your practice in positive and inclusive ways?
    - How might you use scientific knowledge to start a discussion about race and ethnicity?
4. How might using science assist in preparing preservice teachers to address and/or take a stand for human rights and social justice issues?
5. How and/or why could science be used to teach about diversity in teacher education programs (regardless of discipline)?
    - Do feel like you need to be a science teacher to bring this into the classroom or share it with fellow teachers?

CLOSING

Thank you for agreeing to participate in this study.

Before we conclude, is there anything that you feel was not addressed in this interview that should have been, or anything you would like to add?

Inform participants that they will be offered the chance to review the interview transcripts after they are completed.

Again, thank you for participating in this study

APPENDIX F: LESSON PLAN

Science and Human Diversity:
The Empirical Challenges of Racial Classification
Adapted from a lesson developed by Scott Bronson

[*Used for CPSP references and resources*]

Subject Matter: Biology, Anthropology, Genetics, Geography
Time Allotment: 1-2 class sessions
Description: This lesson will help students examine their preconceptions and assumptions about racial categories and understand the impossibility of constructing a consistent system of human racial classification.

OVERVIEW

Most people still believe that the world's people come divided into separate, biologically distinct groups called "races," distinguished by physical characteristics such as skin color, eye shape, and hair texture. The idea of race assumes that variation in these superficial traits correlates with other innate differences, including intelligence and aptitude - in other words, that members of one race are fundamentally more similar to each other than to members of another race.

Human beings across the world do in fact vary in their physical appearance and genetic composition. And traits like skin color, eye shape and hair texture are influenced by genes we inherit from our parents. But do patterns of human variation map onto "races"? Why do we classify the way we do, using some traits while ignoring others? Is there a logically consistent way of assigning individuals to a biological "race"?

This lesson will help students discover the fuzzy, inconsistent nature of racial classification - including how and why patterns of human variation defy racial categorization - and learn about some of the hidden values and assumptions that underlie the reasons we classify the way we do.

Students will first explore their own preconceptions about race by sorting themselves according to which race they think they belong to and listing the criteria they used. Students will then be asked to re-sort themselves according to several of their own observed genetic traits. These results will be compared within and between "races" to explore the impossibility of consistent human racial classification.

GLOSSARY

gradual variation	non-concordance
within-group vs. between group variation	genotype
phenotype	natural selection
sexual selection	gene flow
polymorphism	allele

OBJECTIVES

1. Confront the inconsistencies inherent in any attempt to classify humans according to innate racial categories.

2. Better understand patterns of human variation, including how the geographic distribution of physical traits does not follow racial lines but rather cuts across them.
3. Introduce three basic concepts of human biodiversity: gradual variation, non-concordance and within-group vs. between-group variation.
4. Understand the importance of logical consistency in scientific reasoning and experiments.
5. Contribute information to class discussions.

MATERIALS

General

RACE - The Power of an Illusion, Episode 1 - *The Difference Between Us*

- RACE companion Web site www.pbs.org/race:
  - Sorting People interactivity + Go Deeper
  - Human Diversity interactivity + Go Deeper
- Human Traits Worksheet; Sickle Cell and Skin Color Handout (both attached)
- DNAI Web site

Optional Readings

Jonathan Marks, "Scientific and Folk Ideas about Heredity":
http://www.uncc.edu/jmarks/interests/Baltimore.html
Jared Diamond, "Races without Color," Discover Magazine, 11/94 (www.discover.com/archive)
Stephen Jay Gould, "The Geometer of Race," Discover Magazine, 11/94
(www.discover.com/archive)

Lesson Plan Activities

ACTIVITY #1

Articulating Preconceptions: What Do Students Believe?

Brainstorm the different races of the world and list all the "races" across the whiteboard. Students might use different and inconsistent kinds of labels for their races (see below). This should not be discouraged.

If possible, have students physically group themselves in the classroom according to the race they think they belong to. When everyone has joined a group, ask each group to generate a list of the criteria for membership in their "race" (e.g., skin color), and post the list on the whiteboard under their respective racial label.

NOTE: Some students may resist joining any of the designated racial groups. That's okay, but they must then add whatever label each would apply to him or herself to the list of racial labels, even "human being."

As a class, briefly note and discuss any inconsistencies across racial labels - for example, categories based on anthropology (Mongoloid, Caucasian, Negroid) vs. color (Yellow, White, Brown, Black) vs. geography (Asian, European, African) vs. ethnicity (Arab, Jew, Kurd, Hmong) vs. nationality (Mexican, Puerto Rican) vs. language (Hispanic), etc. - and similarly discuss the membership criteria listed on the board. Are they all comparable?

ALTERNATE ACTIVITY #1

For racially homogenous classes
Ask your students to do the "Sorting People" activity, below.

This interactivity challenges users to "sort" 20 people (images provided) into five federally recognized categories. Once they finish sorting, students learn (a) how the U.S. government would classify these people; (b) how each person self-identifies; and (c) each person's ancestry. Students can then move on to the "Explore Traits" activity where the same 20 people are re-sorted according to skin color, blood type and fingerprint type.

ACTIVITY #2

Problematizing Student Assumptions: Creating an Inventory of Traits

Screen the first five minutes of Episode 1 - *The Difference Between Us*, beginning with the opening titles (00:45 - 05:23; DVD Scene #2) - this is **Clip A**.

Stop the video and ask students if they too believe their closest genetic matches are with others in their own racial group. As a class activity, ask your students to brainstorm definitions of "race." List each definition on the board.

If possible, pass out the Human Traits Inventory Worksheet, which lists several traits influenced by our genes. Have the students work in small groups to analyze their own physical traits and fill out the worksheet. Otherwise, discuss this with the class as a whole by show of hands.

If previously grouped, have students re-form their original "racial" groups. Then, proceeding down the list of traits on the worksheet, ask the students to physically re-group themselves in the classroom by each successive trait (those with hitchhiker thumb on one side of the room, those without on the other side, etc.).

After going through the entire list, discuss the following: What do the students notice about the new groupings? Do any of them match up or co-vary with their original racial groupings? How would students divide themselves now on the basis of genetic similarity and difference, taking into account all of these traits? Would it be easier to categorize people according to race if we used more traits? Why or why not?

Now, have the class re-visit the original list of membership traits for each "racial" group generated earlier (these should already be listed on the whiteboard). Discuss the following: Why did they choose some traits but ignore others when dividing into racial groups? Why do we assume that traits like skin color are more meaningful than whether or not your tongue curls or whether or not your earlobes are attached? What do students think of their earlier definitions of race?

NOTE: Many students may be troubled and confused as they begin to scrutinize the "commonsense" racial categories we have all taken for granted but never examined. This cognitive dissonance is to be expected. You might re-assure students that we're not claiming that race isn't "real" (see discussions of "social race" at the end of Episode 1 and the other two episodes), but that the biological criteria we use are fuzzy, inconsistent and don't correspond to real patterns of human variation.

At this point, if it is a diverse class, perhaps re-visit the common racial skin color labels (red, yellow, white, brown). Have the class divide into groups of eight or so, and have them compare

their skin colors using the inside of their upper arms (as is done in the film). What do they find? Are all "black" people really darker than all "white" people? What about individuals from East Asian, Latino and Native American backgrounds? South Asians? What color are they really? (This can be done even with a racially homogenous class, but is best paired with the "Explore Other Traits" activity in the Sorting People activity).

ACTIVITY #3

Mapping Traits onto Racial Categories

Summarize Jared Diamond's "Race without Color," from Discover Magazine (www.discover.com/archive), which includes a discussion of how various inherited traits are distributed geographically.

If possible, have students work in small groups to make a chart that groups populations into "races" for each of the following traits. Otherwise, use whole class discussion format and show of hands (NOTE: advanced classes may also want to research these traits in other populations for a more complete picture):

- Dark skin/medium skin/light skin
- Lactose tolerance/intolerance
- Epicanthal eye-folds/no epicanthal eye-folds
- Sickle-cell carriers/not sickle cell carriers
- Shovel-shaped incisors/other incisors

Include here a discussion about Pangaea and the influence of plate tectonics (continental drift) on the current geography of the continents. This will help put into context later discussions about phenotypic differences among humans. Then, using different colored pins and a photocopy of a world map, mark the geographical distribution of one or more of the traits.

As a prelude to discussing the class's findings, ask students to define "genotype" and "phenotype." Does phenotype always reflect genotype? What other factors might affect phenotype besides the genes? Note that with the exception of sun-tanning on skin color, the phenotypic traits above do closely reflect genotype. Emphasize that very few traits are influenced by only one gene. Most traits are influenced by many genes, interacting with each other and with the environment in a very complex dance that scientists have barely begun to understand.

Discuss the class's findings. What surprised students the most? Does the geographic distribution of these traits match up and co-vary with what we conventionally think of as races? Or do the traits cut across racial lines?

For further discussion, reference the Human Diversity section (select "Physical Appearance") of the RACE Web site to see how some of the traits we usually think of as racial are distributed geographically.

ACTIVITY #4

Why Racial Classification Doesn't Work
Understanding Gradual Variation, Non-Concordance and Within- vs. Between-Group Variation

We've now seen how difficult it is to find a consistent racial classification system that works for everyone. Show the following two video clips. As they watch, ask students to look for three underlying characteristics of human variation that explain why racial classification doesn't work.

CLIP B: (5 minutes) - on skin color and gradual variation; which begins with Alan Goodman on the difficulty of measuring race, ends with Joseph Graves taking us on an imaginary walk from the tropics to the pole. (22:35-28:03; DVD Scene #8 [back up 20 seconds from the start of Scene #8 to include the statement by Alan Goodman about the difficulty of measuring race])

CLIP C: (9 minutes) - on non-concordance and within-group vs. between-group variation. Begins with Alan Goodman talking about concordance, ends with the narrator explaining that sickle cell results from having ancestors who lived in malarial regions. (32:20 - 40:46; DVD Scenes #10, #11, #12)

Before moving on to a discussion of why racial classification doesn't work, make certain your students understand sickle cell trait and the skin color stories told in the film using the following handouts, as necessary.

NOTE: For an excellent lab on how selective forces affect allele frequencies using the example of sickle cell, visit the Genetics Project Web site:
http://chroma.mbt.washington.edu/outreach/genetics/sickle/sickle-bean.html

Handouts

Sickle Cell Handout
Sickle cell anemia is a hereditary disease that arises from a single mutation (SNP or single nucleotide polymorphism) in one of the genes that code for the hemoglobin protein in our red blood cells. Hemoglobin carries oxygen through the bloodstream to the body.

People who inherit two copies of the mutated hemoglobin gene, one from each parent, get sickle cell anemia. Their red blood cells become sticky and stiff and sometimes become sickle shaped. These "sickled" cells tend to get stuck in the narrow blood vessels known as capillaries, blocking the flow of blood. Sickle cell anemia is a very painful disease and can be life threatening.

But the larger number of people who inherit just a single copy of the mutated gene are known as sickle-cell carriers. They usually don't become anemic and interestingly, sickle cell carriers tend to be resistant to malaria, a deadly disease.

Malaria is caused by a parasite carried by the Anopheles mosquito. After humans started practicing agriculture, the mosquito thrived in standing pools of water that appeared on the cleared land. Scientists believe that the sickle cell mutation arose independently four or five different times in human history, no more than 10,000 years ago, and probably much more recently. Because carrying one sickle cell gene conferred a survival advantage in areas of the world where malaria was common, the sickle cell mutation was positively selected and passed on in those regions.

As humans migrated, the sickle cell trait spread, not by contagion, of course, but through reproduction. Population geneticists call it 'gene flow' when a gene variant like sickle cell passes from one population to another. As a result of these historical and environmental influences, sickle cell is commonly found in central and western Africa, but not Southern Africa. It is also

found on the Arabian Peninsula and over into India, as well as up through Turkey, Greece, Albania, Sicily and Italy and other parts of the Mediterranean basin.

Carrying the sickle cell variant of the hemoglobin gene, therefore, is a marker not of race, but of descent from people who once lived where malaria was common [show map of the spread of sickle cell].

NOTE: another mutation on the same gene but at a different locus also confers resistance to malaria, and in its double form also causes a blood disease. This disease is known as thalassemia. Thalassemia is most common in parts of southern/southeastern Asia and southern Europe.

Skin Color Handout

Why do we have different skin colors? Scientists can only hypothesize at this point because the genetics of skin color is poorly understood. But we do know that skin color tends to correlate not with 'race' but with the amount of ultraviolet radiation in the environment.

People in equatorial areas of the world, where sunlight is most intense, have the darkest skin. This includes sub-Saharan African peoples; Tamils, Dravidians and others from southern India and Sri Lanka; Aborigines in Australia; and Melanesians in the South Pacific. People living in areas where sunlight is less intense, further north and south, tend to have lighter-colored skin.

Scientists don't know why this is, but they have several theories. One theory highlights the role of vitamins and natural selection. The reasoning is as follows:

Dark melanin (skin color variation is controlled by the kind and amounts of pigment in our skin called melanin) acts as a natural sunscreen, blocking ultra-violet (UV) radiation. Too much UV radiation destroys an important enzyme made under the skin called folate. If pregnant mothers don't get enough folate, their infants may be born without a full brain, spinal cord or with other neural-tube disorders. By this reasoning, anthropologist Nina Jablonski suggests that dark skin would be a selective advantage in the equatorial areas of the world because it would block more UV radiation and thus prevent the destruction of folate (see "A New Light on Skin Color" in Resources, below). Thus, darker-skinned people would be better able to survive and reproduce in these areas.

On the other hand, the body needs some UV radiation to manufacture Vitamin D under the skin. Without enough Vitamin D, humans are prone to rickets, a crippling bone disorder most common in young children. Scientists hypothesize that among groups of early humans who migrated to regions far from the equator, where there was less sunlight, those individuals with lighter skin were better able to survive and reproduce (because they could absorb enough UV radiation to produce adequate amounts of Vitamin D). Thus light skin was increasingly selected for in those areas. (Today, most of us get Vitamin D from fish oil, cereals, and fortified milk - foods not available to early humans until we developed fishing and farming technologies).

Over time, these two contrasting influences created a marked difference in the appearance of people living in areas with different amounts of UV radiation.

NOTE: Some people assume that dark melanin provides a selective advantage because it protects against skin cancer by blocking UV radiation. While dark skin does protect against skin cancer, it does NOT provide a selective advantage. That's because skin cancer doesn't usually manifest until later in life, after the childbearing years. Unless a trait affects the ability to reproduce, no natural selection will occur and traits - positive or negative - will continue to be passed down.

An alternative theory (favored by Darwin) suggests that sexual selection drove the evolution of different skin colors and the distribution of other surface traits like hair form. According to this scenario, certain cultures (for one reason or another) came to value dark skin while others valued lighter skin color pigments. Individuals with the favored appearance in a particular culture would have the most opportunities to mate and have more children, just as peacocks with the biggest tail feathers are favored by peahens and thus out-reproduce other peacocks. Over time, this skewed reproduction would result in differences between cultures that preferred different traits. The advantage to this theory is that sexual selection can spread a favored trait through a population very quickly, while natural selection works more slowly.

Now, based on the film clips, ask the class to identify and describe three characteristics of human variation that would explain why it is so difficult to classify humans into racial boxes.

The three characteristics are:
Gradual Variation. Variation of traits is generally continuous, with no clear boundaries between them. As Joseph Graves illustrates in Episode 1 (through his imaginary walk), it is impossible to say where one race ends and another begins. Because of gene flow, groups living close to each other tend to be more visibly similar, while groups far away tend to be less so. Geography is a better explanation for similarity than race.

Non-Concordance. Human variation is highly non-concordant. One trait rarely co-varies with or predicts for another. This is because most traits are influenced by different genes, and genes are inherited independently one from another. Knowing a person's skin color does not help you predict other traits, such as height, blood type, or sickle cell. As Alan Goodman says, "Skin color or eye color or hair color is not correlated with height or weight. And they're definitely not correlated with more complex traits like intelligence or athletic performance." In a nutshell, racial profiling doesn't work on a genetic level.

Within-Group vs. Between-Group Variation. Most of the world's diversity can be found in any local population. As Richard Lewontin first observed, on average, 85% of all human variants can be found within any local population, be they Swedes, Hmong or Fulani. (About 93-96% can be found on any continent, which means only about 4-7% of human variation is explained by continental divisions). In other words, as Lewontin points out in his book Human Diversity, if a neutron bomb tomorrow wiped out everyone in the world except for Nelson Mandela's Xhosa people, 85% of the world's genetic variation would still be left, though the remaining population would on average be darker skinned. Because of this huge within-group diversity, knowing an individual's purported race tells us little about his or her specific genes and traits.

ACTIVITY #5

Reading and Class Discussion
As a final exercise, summarize and discuss the following article about our myths and misconceptions about racial classification and its inherent subjectivity.

Jonathan Marks, "Scientific and Folk Ideas about Heredity."

Students may also want to read the "Go Deeper" article in the Sorting People section of the RACE web site.

As a culminating activity, ask students to write an essay addressing the following questions (this essay will be used for assessment):

Consider this conventional definition of race: "The idea of race assumes humans come divided into several distinct groups, each of which carry a set of innate traits. Those who are members of one race are more genetically similar to each other, and more different from members of another race."

Is this definition scientifically sound given the results from the student activity, the film clips and the readings? Why or why not? What basic scientific criteria have to be met for this definition to work? Have your ideas about race been changed by this exercise? Explain.

ASSESSMENT

Any assessment will be at the professors' discretion. Students may be evaluated based on their participation in class exercises and the thoroughness of analyses during class discussions. Film clips and topics used during class discussion as well as how students used these resources to support their positions can be used as a guide for the instructor's assessment.

EXTENSIONS

Planned for Day #2 (if time) view clips and discuss Spencer Wells documentary "The Journey of Man: A Genetic Odyssey" at: http://youtu.be/OV6A8oGtPc4

Summary:
"By analyzing DNA from people in all regions of the world, geneticist Spencer Wells has concluded that all humans alive today are descended from a single man who lived in Africa around 60,000 years ago"

National Geographic:
http://news.nationalgeographic.com/news/2002/12/1212_021213_journeyofman.html

Read/Discuss "From Africa to Astoria by Way of Everywhere" on National Geographic website, which discusses Wells' work in relation to Astoria Queens, New York – one of the most ethnically diverse communities on Earth.

Discussions will take place in the context of racial, ethnic, and cultural differences in the classroom and what science is able to tell us about human diversity.

Read Stephen Jay Gould, "The Geometer of Race." Discover Magazine (November, 1994). Gould tells the fascinating story of how white people came to be named after a mountain range in Georgia, and how German naturalist Freidrich Blumenbach's visual model of five races became popularized and inadvertently fueled notions of racial superiority and inferiority.

Students can explore human genetic diversity further using the Cold Spring Harbor Laboratories computer exercise titled "How Unique Are You?" This exercise will calculate how many other students, out of thousands that have participated in this exercise, have the same genetic profile that they do. Don't be surprised if the answer is zero. Go to the DNAI Web site (http://www.dnai.org/d/index.html) and navigate to the activity by clicking on Human Origins, then Variation, then Interactive Variation Activity.

Explore or discuss in class the related essay taken from the "Go Deeper" article associated with the "Sorting People" section of the RACE Web site. Also read the Background Reading on the history of the Census:

Should We Classify?
Following are the U.S. federal government's current definitions for the racial and ethnic groups we used in the sorting activity:

- ***American Indian or Alaskan Native***. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community recognition.
- ***Asian***. A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
- ***Black or African American***. A person having origins in any of the black racial groups of Africa. Terms such as "Haitian" or "Negro" can be used in addition to "Black or African American."
- ***Hispanic or Latino***. A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture of origin, regardless of race. The term "Spanish origin" can be used in addition to "Hispanic or Latino."
- ***Native Hawaiian or Other Pacific Islander***. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
- ***White***. A person having origins in any of the original peoples of Europe, the Middle East, or N. Africa.

Most of these categories were introduced in 1977, in response to new civil rights laws designed to remedy discrimination. Look closely at these definitions. Is everybody defined in the same way? To be categorized as Native American, for example, requires "tribal affiliation or community recognition" - a condition of no other category. The definitions for African American includes a reference to "black racial groups," while none of the other categories mention race. In fact, Hispanic or Latino is defined as a "Spanish culture of origin, regardless of race." The category Native Hawaiian or Other Pacific Islander was only introduced in 1996 - previously, it was lumped together with Asians.

What reasons might exist for defining these groups in these seemingly contradictory ways? Are the criteria social or scientific?

Even though there's no consistently objective way to classify people, can you think of reasons why we would want the government to categorize or track information on racial groups? What would happen to efforts to remedy discrimination and inequality if we didn't have any racial data?

ADDITIONAL RESOURCES

RACE Web Site

- Sorting People; Go Deeper
- Human Diversity
- Richard Lewontin, Human Diversity, Scientific American Library, 1982, 1995
- Stephen Jay Gould, The Mismeasure of Man, W.W. Norton, 1981, 1996
- Saadia Iqbal, "A New Light On Skin Color," National Geographic Magazine Online. (http://magma.nationalgeographic.com/ngm/0211/feature2/online_extra.html)
- DNA From the Beginning (http://www.dnaftb.org/dnaftb/)
- DNAi Web site: (http://www.dnai.org/d/index.html)
- Human Migration Map: http://ngm.nationalgeographic.com/img/big-idea/queens-genes.jpg

APPENDIX G: PHASES OF THE STUDY

The following phases correspond to exploring the phenomenon of science as a critical method for teaching about diversity in the case of three preservice teacher education courses. There was total of 3-5 class visits per course, depending on scheduled meeting times. Data was collected and analyzed during the months of November 2014 to March 2015. The duration and procedures in each phase are detailed below.

Phase 1

Online Questionnaire: 15-20 minutes; dates/times for interview scheduled

Prerequisites: Send recruitment emails to professors of teacher education courses matching the following criteria:

a) especially designed for undergraduate preservice teachers;
b) required either for admission into the TEP or for licensure;
c) emphasize social issues in education, i.e, student diversity and teaching in diverse settings

The voluntary questionnaire was administered online to students and professors in each of the three courses, and included a brief description of the study and an informed consent agreement. Dates/times for the interview was also determined using the form. Some observations and preliminary data analysis began during this phase.

The primary goal of Phase 1 was to collect and begin analyzing participants' demographic information and initial views on human differences, with respect to science, diversity (i.e., race, ethnicity, culture, etc.), and teaching to diverse student populations. This data informed the observations, class discussions and interviews, and was later used for triangulation to help ensure the accuracy and trustworthiness of the study.

Phase 2

Observations: 2 x 75 minutes for biweekly classes; 1 x 150 minutes for weekly classes

Classroom observations began during Phase 2. Observation field notes included rich descriptions of each setting, participant responses and behaviors, in order to provide context to the observation experience. The field notes also used codes/symbols to represent behaviors, etc. This provided a thorough record using fewer words, which allowed more data collection for later analyses (LeCompte, 2000; Spradley, 1980).

Phase 3

Researcher-led discussion and participant observation: 1 x 75 minutes

At each instructor's discretion at least one researcher-led discussion was conducted with the entire class. The discussion consisted of various instructional methods, including scientific information that helped explain elements of human diversity (Appendix F). As the lesson(s) aligned with course content, they did not impinge on class time or on students who chose not to participate in other components of the study (i.e., questionnaire or interview). Participant observations and data analysis continued during this time.

Phase 4

Semi-Structured Follow-up Interview: Approx. 45-60 minutes

In this phase, semi-structured interviews were conducted with 14 of the 30 students who completed the questionnaire as well as two course instructors. The interviews were held at the convenience of participants either by phone, Skype, or in person, and was guided by protocols in Appendix F. The semi-structured format allowed for a variety of responses, which were audio-recorded, transcribed, and then coded and analyzed for emergent themes. Concluding analyses were conducted throughout and following Phase 4 (Spring 2015). The final two dissertation chapters were written during this time.