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Exploring Science Identity: The Lived Experiences of Underserved Students in a University Supplemental Science Program

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By

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Dedication

To my husband, three children,

and my mama and daddy

for their love and endless support

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Abstract

Underserved students attending under-resourced schools experience limited opportunities to engage in advanced science. An exploration into the influence a supplemental science program has on underserved students' acquisition of science knowledge and skills to increase their pursuit of science was conducted to help explain science identity formation in students. The proliferation of supplemental science programs have emerged as a result of limited exposure and resources in science for underserved students, thus prompting further investigation into the influence supplemental science programs have on underserved students interest and motivation in science, attainment of science knowledge and skills, and confidence in science to promote science identities in students. Using a phenomenological qualitative approach, this study examined science identity formation in high school students participating in a university supplemental environmental health science program. The study explored high school students' perceptions of their lived experiences in science supplemental activities, research, and field experiences and the influences these experiences have in relation to their science identity development. The university supplemental science program was an eight-week summer program in which students interacted with a diverse group of peers from various high schools, through engaging in environmental health science rotations, field experiences, and research with faculty advisors and graduate student mentors. Data collection included existing program evaluation data including, weekly journals and exit interviews, as well as follow-up interviews conducted several months after the program concluded. The study findings from a three step coding process of the follow-up interview transcripts provided six emerging themes as follows: (1) promoting interest and motivation to pursue new areas of science, (2) mechanisms in the acquisition of science knowledge and skills in scientific practice, (3) confidence in science knowledge and abilities, (4) understanding and applying science in the world, (5) emerging relationships with peers and mentors in science, and (6) aspirations to be a science person in the scientific community. This research study informs other supplemental science programs, has implications for improved science curricula and instruction in K12 schools, as well as explains how exposure to science experiences can help students gain identities in science.

Key words: Science identity, K-12 science education, supplemental science programs, underserved students, under-resourced schools, phenomenology

Chapter 1

Introduction to the Problem

Science achievement gaps are a persistent feature of US public schools. Evidence suggests these gaps exist because of inconsistent science standards, inadequate science instruction, and limited science resources and opportunities for underserved students (Jenkins & Nelson, 2005; Lyons, 2006; Osborne & Collins, 2001; Sjøberg & Schreiner, 2005). As a result of inadequate science learning, "minorities are severely underrepresented in both science and science education," (Medin & Lee, 2012, p. 1). Limited opportunities and exposure to effective learning and activities in science has made it difficult for underserved students to gain science knowledge and skills, and envision themselves as someone who conducts science, thus hindering science identity formation in students (Carlone, 2004; Carlone & Johnson, 2007. 2012). While science achievement is an important barrier for underrepresented students, much less is known about the science identity development of underserved students. Carlone and Johnson (2007, 2012) defines science identity as a compilation of science knowledge and an understanding of the world scientifically, as well as the acquisition of skills in scientific practice that promotes the perception of oneself as a science person through three interconnected characteristics of *competence, performance, and recognition.*

In response to the challenges that exist in K-12 schools, science education has been in a constant state of change through the institution of science policies and initiatives to improve science learning and achievement for all students. A significant obstacle to science learning, engagement, and achievement in underserved students is "ineffective science teaching and counterproductive support perpetuated by teachers, administrators, parents, and peers regarding 'who belongs' or who gains access to enriching science activities and programs, which can perpetuate negative views of one's self and the world" (Olitsky, Flohr, Gardner, & Billups, 2010, p. 1209). Underserved students are most frequently minority students attending urban/rural schools with 60% or more minority students coming from low-socioeconomic backgrounds, and may also be a first generation college student or a student learning through electronic media (distance/online learning/GED) (Rendon, 2006). For example, educational disparities in science emerge very early in schools for underserved students, and there's evidence that disparities among racial and ethnic groups are seen at the elementary and high school level (Anderson, 2015). While gaps in achievement have narrowed in science for students, African American and Hispanic students continue to achieve at lower levels than Caucasian and Asian students (Anderson, 2015). Among eighth grade students, the average score in science on the 2011 National Assessment of Educational Progress test was 152, but African Americans' and Hispanics' scores are lower, 129 and 137, while Caucasians' (163) and Asians' and Pacific Islanders' (159) scores are 163 and 129 which are above the national average (Anderson, 2015). There are racial and ethnic disparities at all educational levels in the rate at which groups participate in science and engineering curricula (National Academy of Science, 2011). These disparities can negatively impact students' identity and the 'kind of person' they are seeking to be in science and in life (Carlone & Johnson, 2007, 2012; Gee, 1999, 2000, 2001). Although K-12 schools are attempting to make significant changes to increase interests and learning in science for students, "the main issue at stake here is the potential to construct and inhabit an intelligible science identity, one that is valued in and for itself, that is congruent with other aspects of a person's identity, and that is also (seen to be) judged by others as being of worth," (Archer, Dewitt, Osborne, Dillon, Willis, & Wong, 2010, p. 628).

An exploration of science identity formation involves how underserved students found meaning in their science experiences and made relevant connections to how society and culture structure these latent meanings in their lives (Rick, DeVane, Clegg, Peters, Songer, Goldman, & Hmelo-Silver, 2012; Wonch Hill & McQuillan, 2015). Additionally, through a science identity lens, the social and cultural components of learning have offered a new way to view science learning, thus advancing the search for more equitable science education for underserved students (Brickhouse & Potter, 2001; Carlone, 2003, 2004; Lemke, 2001; O'Neill & Polman, 2004: Cole, 2014). This sociocultural view relies both on schooling and other experiences as valued sources of student learning and identity development. In comparison to K-12 schools where students were primarily limited to instruction guided by science textbooks, basic laboratory experiences, and a 'one size fits all' approach to science teaching, supplemental instructional programs can provide academic opportunities for students to engage in the scientific community with real scientists (Lynch, 2001; Green, 2006). Supplemental science programs are immersive academic programs providing science instruction, activities, and research in a university setting focusing on various science disciplines to increase science learning, achievement, and pursuit of science postsecondary majors and careers. Furthermore, the science identity model takes into account the social construction of science learning and achievement, and the influence of one's gender, race, and ethnicity on one's science identity and the individual's reasons for pursuing science (Carlone, 2004; Carlone & Johnson, 2007, 2014; Carlone, Cook, Wong, Sandoval, Barton, Tan, & Brickhouse, 2008). For example, science identity formation has been strongly influenced by the limitations and assets accessible in the students' environment, thus "meaning developed by groups in their everyday activities can reflect or counter meanings implied by the larger social structures"

(Eisenhart & Finkel, 1998, p. 44). The influence of cultural practices has also promoted specific definitions of who were considered ‘science people’ (Carlone & Johnson, 2007). Cultural and social influences are innate factors in shaping science identity for underserved students (Eisenhart, 2001), and this study conducted an exploration of the influence their experiences in a supplemental science program had on the formation of science identities in underserved students. Although the need to equalize resources in under-resourced schools remains paramount to student learning in science, science identity development is also important to increasing student interests, engagement, and overall learning in science, when both formal science learning and opportunities for science identity development are made available.

Scientific Knowledge and Training in the Modern Economy

In the modern world, scientific knowledge undergirds some of the most versatile and essential professions, but the existing educational channels to train science professionals in the US has been insufficient to meet the needs of the nation and the world (Hossain & Robinson, 2012). Science knowledge and skills have been an increasingly precious resource throughout the world, and U.S. schools and universities have fallen significantly short in preparing underserved students for science careers that meet the world market demands (Aschbacher, Li, & Roth, 2010). The National Center on Education and Economy found that science education and training has been historically based on an era when workers needed only a basic knowledge of science, but as the US and the world became more deeply grounded in professional practices, the demand for skilled and highly trained workers in the science field has increased (Hossain & Robinson, 2012).

Hence, the US has lost ground in science because many highly paid science professions have gone to foreign or foreign-born workers who have been extensively trained from a very young age to be knowledgeable competitors in the science world marketplace (Hossain & Robinson, 2012). The 2012 U.S. Congress Joint Economic Committee report found that in relation to other industrialized nations, the US produced more graduates in STEM, but the US ranked 23rd for 25 to 34-year-olds employed in STEM professions worldwide (Schmidt, Burroughs, & Cogan, 2013). Furthermore, in 2015 the US needed an estimated 400,000 new STEM graduates (Obama, 2009), but only 15% of college graduates acquired STEM degrees, which impacted the US in the STEM world marketplace (Hossain & Robinson, 2012).

A limited number of young Americans joined science professions which have been partly attributed to the lack of rigorous standards-based science education (Quinn, Schweingruber, & Keller, 2012). K-12 science education has been disorganized and has lacked standards-based focus in the earlier grades, which has diminished students' interests in science at a very early age. Schmidt and colleagues (2013) noted that K-12 science driven by the traditional textbook approach has reduced underserved students 'interest and motivation in science, and their pursuit of postsecondary majors and careers in science, hence underrepresentation of minorities in science professions and careers. Additionally, Gormally, Brickman, Hallar, & Armstrong (2009) noted contrary to the textbook approach, inquiry-based instruction has been found to increase science literacy skills and confidence in students, which is a key component of the supplemental science program design that was explored in this study. Inquiry-based instruction is an instructional approach that promotes an active process that is guided by teachers, mentors, scientists, and/or their peers through conducting hands-on problem-based investigations and research (Keys, & Bryan, 2001; Savery, 2015)

An evaluation of science literacy conducted by the Program for International Student Assessment (PISA) found the U.S. average science score for 15-year-old students was 497, which placed twenty-two countries with higher average science scores than the United States in 2012 (Programme for International Student Assessments [PISA], 2012). Additionally, score gaps in science continue to exist, which has been attributed to the diminishing number of students who pursue science post-secondary majors and careers. In 2014, Ninety-one percent of young adults 25 to 29 years of age had a high school diploma or its equivalent, and 34 percent had a bachelor's or higher degree. Average earnings for 25- to 34-year-olds with higher levels of education in 2013 were higher. In addition, there was a 35-point score gap between White and Black U.S. students in 2014, and a 36-point gap in 2011 performance scores (Kena, Musu-Gillette, Robinson, Wang, Rathbun, Zhang, Wilkinson-Flicker, Barmer, & Dunlop Velez, 2015; Snyder & Dillow, 2015).

Student performance in science has also been attributed to the U.S. educational system's failure to successfully engage underserved students in the scientific community. Tajfel (1982a) noted that students must have a "sense of belonging" in the learning community, which serves as a means to encourage students to view themselves as scientists and a part of the scientific community. K-12 education has faced a tremendous challenge when training American teachers to motivate underserved students toward the science community (Hossain & Robinson, 2012). Teachers lacked in-depth knowledge of science as revealed by the findings of the Congressional Research Report for Congress (Kuenzi, 2008) which reported that 14.5% of high school math teachers and 11.2% of high school science teachers did not have a major or minor in the subjects they were teaching. In the 2012 Report of the National Survey of Science and Mathematics Education (Banilower, Smith, Weiss, Malzahn, Campbell, & Weis, 2013) an analysis of how teachers were distributed among schools found that poverty (under-resourced, low-performing) schools were more likely to have teachers with five or fewer years of teaching experience, and were not certified in the content area they were teaching. For example, science classes composed of high achieving students in high-performing schools were more likely to be taught by teachers with strong science content backgrounds versus those students at struggling schools with lower levels of achievement (Banilower et al., 2013). Teachers had limited knowledge and confidence in their abilities to teach science which attributed to a number of issues, such as inadequate poor instructional practices, and limited student learning and achievement (DeBoer, 2000). Consequently, students became disengaged and found science subjects to be too difficult, thus resulting in being ill-prepared to meet the challenges they will face in high school and college (Balfanz, Herzog, & Mac Iver, 2007; Hulleman & Harackiewicz, 2009). As a result of these issues, underserved students lacked sufficient science knowledge and an identity of themselves as scientists.

Substantial disparities in science classrooms has also been attributed to the reality that half of the instructional time in K-12 classrooms has been allotted to language arts and mathematics, thus resulting in a random splattering of unconnected science courses and scientific topics being taught (Schmidt et al., 2013). Consequently, underserved students became disinterested in science, which halted their science identity formation. Malcom-Piqueux and Malcom (2013) stated in reference to STEM, "that this 'interest gap' originated from the disparate experiences of girls and minority boys in K–12 schooling environments," and "may be more accurately characterized as an 'opportunity gap,' originating from inadequate academic preparation, lack of exposure to engineering, tenuous personal identification with engineering, and inadequate knowledge about the steps necessary to pursue an engineering career" (p. 27). For women and minorities this was a significant obstacle when seeking a pathway in engineering and/or other science related fields (National Science Foundation [NSF], 2014; United States Commission on Civil Rights: United States Department of Education, 2014); Malcom-Piqueux & Malcom, 2013). Furthermore, K-12 schools with the highest quartile of students eligible for free/reduced lunch offered only one advanced placement (AP) science course on average per school year (Banilower et al., 2013). These issues of poor science teaching, limited exposure, and minimal AP and science courses offered posed obstacles for underserved students when traversing the K-12 system up through to higher education, trade/technical schools, and/or community colleges.

A wealth of research also stressed the importance of student-teacher interactions, and how these relationships helped to include underserved students into the sciences and the scientific community (Slovacek, Whittinghill, Tucker, Peterfreund, Rath, Kuehn, & Reinke, 2011). By gaining insight into how underserved students learn through building these relationships, teachers helped students gain science knowledge to build an identity in science. Gullatt and Jan (2003) posited that teachers need to serve as role models bound by principles of practice which provides individualized attention for underserved students, as well as allows for peer support opportunities for students through cooperative learning groups that encourage students to participate in outside-of-school activities and supplemental programs (Lazarowitz & Karsenty, 1990). For example, teachers that encouraged and set expectations for underserved students to participate in science academic opportunities in- and outside-of-the school environment promoted student learning and membership in the larger science community (Tajfel, 1982a), which supported a belief system in one's identity and ability as a science person.

Underserved students have not been equipped to meet science goals and expectations set before them in their K-12 educational careers. Prior to high school, students in upper elementary and middle school frequently became disengaged and disinterested in learning science gradually because of limited exposure to science in school. As Yager stated (2000), "while there are many reasons for this disengagement; a chief cause is the egregious mismatch between the school curriculum and the intellectual and emotional needs of young adolescents" (p. 329).

Underserved students struggle to acquire the science knowledge and skills needed in order to be competitive in science professions globally; hence, about 50% of students exited high school with a limited science identity grounded in science knowledge and skills that were needed to enter the science workforce (Levinson & Palmer, 2005; Next Generation Science Standards, 2013). Additionally, the majority of underserved students and their parents have come to appreciate the advantages a college degree in the sciences provides; however, many of them cannot envision college as attainable or affordable. To curtail these issues facing underserved students in science education, a wealth of educational research advances the value of students doing science research in- and outside-of-school to help them gain science knowledge, thus promoting positive science attitudes and learning outcomes, as well as the pursuit of postsecondary science majors and careers (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). Subsequently, by providing enriching support in science, through in- and outside-of-school quality instruction, rigorous science curricula and research, underserved students gained and sustained commitment and involvement in science and their pursuit of science careers (Chemers et al., 2011).

Equity in K-12 Science Resources

Initially, science education in the 1900s to 1950s focused on an individual's relationship to science, but evolved in the 1960s to 1980s into a neutral, culturally devoid discipline. In U.S. K-12 schools, "science and mathematics education has been linked to technological advances, the economy, and the well-being of the United States citizenry since the Sputnik Shock of 1957" (Yager, 2000, p. 327). For example, best practices in science education evolved into an inquiry standards-based approach through student-centered, hands-on, and technologically advanced science content; however schools with high numbers of underserved students were not effectively implementing this approach due to significant limitations in science resources, funding, teachers, and opportunities in- and outside- of-school. Emerging from Sputnik, the Vietnam War, and the supremacy of Germany and other foreign nations, K-12 science education moved to an inquiry standards-based approach. Even though access to enriching activities increased for all students, underserved students still experienced disparities in science and were hesitant to enter rigorous science programs and activities because of their disadvantages academically (Felix, 2009). In the United States, there were a significant number of urban and rural schools that had over 60% of the underserved student population (National Institute of Health, 2014). Thus, exposure, access, and resources in these schools with high percentages of underserved students were at a deficit, and have not rebounded in recent years (Nichols & Clinedinst, 2013). Consequently, these barriers to science learning posed substantial challenges for underserved students who aspired to engage in the sciences at the postsecondary level and in their careers. Despite major attention and investment by the U.S. Government in K-12 science resources and technological advances, schools did not successfully facilitate an equitable and successful pursuit of K-12 science learning for all students (National Center for Public Policy and Higher Education [NCPPHE], 2010).

The No Child Left Behind Act (NCLB) (Act, N.C.L.B., 2001) has influenced K-12 science education, in which it was necessary for schools and school districts to reduce science teaching and learning in order to designate more time for reading/language arts and mathematics (Labov, 2006). The main purpose of NCLB (Act N.C.L.B., 2001) was to close the achievement gap for disadvantaged and minority students (Dahir & Stone, 2003) by focusing primarily on reading and mathematics. Scholars observed reduced quality instructional time for science and other subjects in the school curriculum (Malcom-Piqueux & Malcom, 2013). This reduction and/or elimination of teaching science that began in the lower grades produced a gap in science knowledge for students through middle and high school. Schmidt and colleagues noted (2013) that the K-12 science curriculum encompassed a vast array of topics presented in a disorganized and superficial manner, which was characteristic of the standards at the state and local levels.

The United States Commission on National Security/ 21st Century identified the condition of pre-college science education for underserved students as a critical national security problem (United States Commission on National Security/21st Century [USCN], 2001).   Furthermore, USCNS (2001) noted, “we do not now have, and will not have with current trends, nearly enough qualified teachers in our K-12 classrooms, particularly in science and mathematics” (p. 33). Teachers have often drawn conclusions about the abilities of students to learn science from a deficit model that was influenced by their views on race, ethnicity, and socioeconomic background of their students (George & Aronson, 2003). Additionally, the conditions of schools with a high percentage of underserved students were not conducive to building student science identity resources in the form of knowledge, skills, trust, collaboration, and high expectations collectively (Next Generation Science Standards, 2013). These conditions included school overcrowding, academic deficiencies, behavior management issues, and emotional concerns which posed numerous threats to science learning for underserved students (Rodriguez, 1998). School faculty and staff were more apt to highlight the deficiencies and incapacities of underserved students in science, thus, steering them away from science opportunities (Green, 2006). School administrators focused on end results, teachers were poorly trained, and counselors were indecisive in terms of guiding young people in building an identity that emphasized their strengths (Côté, 2002). For example, underserved students had limited guidance by school faculty and staff, as a result of school staff's limited knowledge and awareness of local, regional, or national science standards-based reforms, thus resulting in limited science exposure and opportunities to do science in their schools.

The most significant impact on student outcomes has been the inequitable opportunities for students to learn rigorous science. Carlone and Johnson (2007, 2014) noted that, students engaged in hands-on learning experiences with an abundance of science resources had successfully formed identities in science; however, students that experienced limited opportunities in science had minimal connections to science and minimal identities in science. Historically, in the learning environment students were largely a product of the content to which they were exposed to in the classroom (Schmidt et al., 2013). K-12 schools normally emphasized science education primarily for those students who were most likely to pursue careers in science or engineering (Labov, 2006). A fairly recent phenomenon, within the past 15 years, has been the standards reform and inquiry-based teaching movement as the recommended approach in science education (Labov, 2006). These science reforms, grounded in culturally relevant inquiry-based science teaching, promoted student learning through building positive experiences for students in science; however, the lack of nationally adopted standards has posed significant obstacles for teachers in educating diverse populations of students. Moreover, science learning supported by cultural and societal influences diminished students' negative views of science (Labov, 2006).

Achievement Gaps in Science

Historically, the educational system's failure to close the science achievement gap for minority students in relation to their Caucasian peers in science has significantly hindered student learning. Standardized measures of achievement revealed significant gaps in science. In the 2011 Trends in International Mathematics and Science Study fourth and eighth graders in U.S. schools were not among the very top-achieving groups in the world in which U.S. fourth graders ranked 7th with a 544 average scale score and U.S. eight graders dropped to 10th with a 525 average scale score (Martin, Mullis, Foy, & Stanco, 2012; Provasnik, Kastberg, Ferraro, Lemanski, Roey, & Jenkins, 2012). Between 1995 and 2011, student performance improved in science for U.S. eighth graders, but had not changed for U.S. fourth graders, however, Black, Hispanic, and American Indian or Alaska Native students performed substantially lower than their Caucasian and Asian or Pacific Islander peers (NSF, 2014). Science standardized assessment scores have shown a 34 point gap in the average scores between African American students (125) and Caucasian students (159), and a 25 point gap in the average scores between Hispanic students (134) and Caucasian students (159) in 2011 (NCPPHE, 2010). Conversely, achievement gaps in science were found among students from diverse demographic groups and low-income families or homes in the kindergarten, fourth, and eighth grades. The National Action Council for Minorities in Engineering 2011-12 Scholars Report revealed that African-Americans, American Indians, and Latinos accounted for 38 percent of the total U.S. population (ages 18 to 24), but earned only 12 percent of undergraduate degrees, 7 percent of master's degrees, and only 3 percent of doctorate degrees in science, technology, and engineering (Banilower et al., 2013). Contrary to the push for the US to lead the world in producing diverse science leaders, science test scores for middle and high school minority students remained low, especially when higher order thinking skills were measured (Yager, 2000).

K-12 assessment data found that 50th percentile science scores for African American eighth grade students were estimated to be at the 10th percentile scores of Caucasian eighth grade students, which continued to reflect a widening achievement gap showing significant disparities among African American and Caucasian students in the sciences (Freeman, Eddy, McDonough, Smith, Okoroafor, & Wenderoth, 2014). These achievement gaps continue to perpetuate the disenfranchisement of underserved students in the sciences, and stifles science identity development when building engagement, science knowledge, skills, and confidence as a science person (Carlone & Johnson, 2007, 2014). Schmidt and colleagues (2013) noted that a student's race/ethnicity and socioeconomic status significantly predicts science learning outcomes, and the lower scores for minority students provides a telling story supporting the need for science education rooted in relevant science curricula, and inquiry-based instructional practices and content.

Culturally Appropriate Science

Historically, science curricula and science classrooms have been devoid of relevant cultural inclusion (Gay, 2010). Culture significantly impacts how underserved students have viewed themselves in the world of science. Schlitz, Vieten, Miller, Homer, Peterson, and Erickson-Freeman (2011) proposed that, "cultures adopt certain tenets and values, and proceed to operate out of them until something large enough comes along to create a change" (p. 2), thus cultural norms have significant importance in relevant science curricula in schools. Furthermore, science educators often made the presumption that "science is pure," and cultural influences may not be a necessary component in science pedagogy (Brickhouse, 2001; Cobern, 1991). Underserved students do not identify with or process the information being taught, which has prompted them to believe they cannot perform science or process scientific information due to cultural differences (Baptiste & Key, 1996).

As noted by George and Aronson (2003), "most schools are organized as bureaucracies with well-defined procedures for dealing with students, teachers, and for working with the community, as well as determines who will be allowed to participate in the educational process, how they will be treated and expected to behave, how their performance will be judged, and down what path they will be directed once they leave the school" (p. 3). While these procedures appear to be acceptable on the surface, there still remains a hidden curriculum in schools, where underlying, unpublished rules have originated from the cultural beliefs of those in authority. Traditionally, underserved students have been victims of this hidden curriculum in schools and "struggled to overcome cultural bias and racial stereotypes that separated them from their White peers" (George & Aronson, 2003, p. 3). The cultural belief systems of educational leaders and teachers deeply impact the pursuit of science and the science identities for underserved students (Carlone, 2004; Carlone & Johnson, 2007, 2012). Teachers' expectations predominantly dictated by the cultural beliefs of society, directly contribute to underrepresentation of these students in science, and their pursuit of postsecondary science majors and careers in the future. A preconception held by teachers was that students from poverty lack motivation, and teachers frequently establish a deficit model of low expectations in their classrooms (Tinto, 1993).

Cultural beliefs and experiences influence school leaders, teachers, and students in the school environment. Although schools have instituted multicultural activities and programs, the majority of schools still base their values, beliefs, and expectation on the White middle class culture (George & Aronson, 2003). For example, Delpit (2001, 2006) noted that African-American boys were commonly raised to be highly physical and desired interaction, which posed threats to the school's culture and classroom teachers' expectations for the behavior of students, resulting in instructional strategies and discipline that countered the student's cultural and community norms of their home. To address these threats, Dana and Davis (1993) recommended teachers address cultural beliefs in the classroom through using language that is ethnically and culturally sensitive, as well as work at becoming more culturally competent, which potentially influences a positive school and classroom culture. Overall, underserved students can develop a positive science identity shaped by a learning environment guided by culturally relevant science (Abrams & Hogg, 1988); thus, identity exchanges take place as they traverse through experiences in their school and learning-community (Côté & Schwartz, 2002). The core components of multicultural pedagogy are to structure the norms, values, and concepts that make up science knowledge which is representative of diversity in the US (Banks, McGee & Cherry, 2001). Educational communities that incorporated traditional science and culture cultivated a positive relationship to science for underserved students through multicultural, culturally inclusive science, (Key, 1999).

Bandura (1997) recognized the influence of the social component of learning and how students gain motivation and self-efficacy, as a result of their lived experiences in the unique learning phenomenon. Science learning communities, similar to the supplemental science program in this study, provides supplement science instruction through many forms, including classroom instruction/activities in-and outside-of-school, and culturally relevant curricula designs that embrace a culturally inclusive science experience. Underserved students, who felt a sense of belonging, build identities that emerged from group membership within the learning community (Tajfel & Turner, 1979). Through gaining access to enriching science experiences within a learning community, such as school-based, and in- and outside-of-school supplemental science instructional programs, underserved students gained science knowledge, abilities, and confidence to do science.

Science Identity

Science identity represents a compilation of experiences which creates a pathway for a student to navigate from one experience to the next in science (Settlage, Southerland, Smith, & Ceglie, 2009). When conducting educational research, “identity is a relatively recent lens through which researchers have examined student learning” (Settlage et al., 2009. p. 105). Aschbacher and colleagues (2010) noted, “there is still much to understand about what invites diverse young people to appreciate, desire to learn, and develop a sense of themselves as someone who does science; how they perceive and pursue their science interests and career options; and why so many young people initially interested in science eventually choose not to continue learning science or pursuing careers involving science" (p. 565).

Science identity theory, which will be discussed in more detail in Chapter 2, represents (a) one who demonstrated meaningful knowledge and understanding of science content, (b) is motivated to understand the world scientifically, (c) acquires skills in scientific practice, and (d) sees oneself as a science person (Carlone & Johnson, 2007, 2014; Gee, 1999). Furthermore, gender, racial, and ethnic identities also influence one's science identity, which relates to the assumptions of this study. In order to study students traditionally marginalized in science, it was necessary in this study to examine learning as a social learning process of identity formation and transformation through participation and membership in communities of practice (Wenger, 1998), which supported the tenets of science identity theory and the qualitative phenomenological research approach.

Problem Statement

A problem facing K-12 science education has been the lack of support, resources, and opportunities for underserved students in science education, which has led to decreased science knowledge and the development of strong science identities in students (Carlone & Johnson, 2007). These gaps in science have hindered the pursuit of postsecondary majors, and careers for underserved students attending low-performing schools in relation to their peers attending high-performing schools (Banilower et al., 2013). Tajfel (1982a) and Shanahan (2009) noted that underserved students bring a very different view of themselves and the world to the learning situation, which influences how they engage in challenging science activities. Engaging in science experiences within a community of practice has often been limited or non-existent for underserved students (Felix, 2009). Underserved students have rarely interacted with peers from different backgrounds, and have experienced limited opportunities to engage in science learning within a community of practice (Lave & Wenger, 1991b). For example, within the context of a supplemental science program, upon entering the program underserved students may see themselves as disadvantaged, and may negatively view themselves and the world in comparison to their more advantaged peers as result of their limited experiences in science (Turner, Hogg, Oakes, Reicher, & Wetherell, 1987).

These limitations may suggest the need to include culturally relevant science in order to motivate underserved students to reach their full potential in the sciences, thus potentially fostering their development of a strong science identity (Schlitz et al, 2011). Being exposed to new, diverse, and challenging science knowledge and ideas, may counter negative school and community influences, experienced by underserved students in science. Additionally, supplemental/pre-collegiate academic instructional programs have been found to improve student learning and achievement in science, as well as encourage their pursuit of postsecondary science majors and careers (Gullatt & Jan, 2003). This was not an evaluation of the supplemental science program, but was a study that examined students' participation in a supplemental science program and the influence these lived experiences had on students' science learning and formation of science identities.

Research Question

The phenomenological research study evaluated the lived experiences of underserved high school students participating in a supplemental science program. The supplemental science program included rigorous science lab work, research, activities, and field experiences in environmental health science. This phenomenological study examined how underserved students perceived their science experiences in the program, in science learning, and in their pursuit of science postsecondary majors and careers. The following research questions guided the study:

(1) *What are students' perceptions of their participation in a university supplemental environmental health science program?*

(2) *What influences do these science experiences have on students' understanding of science, science worldviews, and skills in scientific practice?, and*

(3) *How does program participation influence how they see themselves as a science person with a strong science identity?*

Implications

This research study potentially informs supplemental science programs, helps improve science curricula and instruction in schools, as well as explains how exposure to science experiences can help students gain identities in science. In-depth analysis of the influence supplemental science experiences had on underserved students' views, knowledge, skills, and career interests in science can help demonstrate and explain the science identity process in students. As previously noted, under-resourced high schools have frequently experienced a shortage of science resources, poor science teaching, and opportunities for underserved students to do science, thus promoting underrepresentation of underserved students in science postsecondary majors and careers (Hossain & Robinson, 2012). This research study potentially explains the influence science experiences in a supplemental science program has on the advancement of underserved students' science knowledge and skills relevant to them as individuals in the world, thus becoming a science person with a strong science identity.

Summary

As previously noted, limited resources, poor teacher quality, and lack of exposure in K-12 science education in under-resourced schools has posed significant challenges for underserved students in comparison to students enrolled in more advanced schools (Jenkins, 2004; Jenkins & Nelson, 2005; Lyons, 2006; Osborne & Collins, 2001; Sjøberg & Schreiner, 2005). As previously stated, underrepresentation of minorities in science postsecondary majors and careers in the US are believed to be inadequate in order to meet the needs of the nation and the world (Hossain & Robinson, 2012). Furthermore, a trend in science education focusing mainly on standards reform grounded in inquiry-based teaching has been the suggested approach. Consequently, the acknowledgement that supplemental science programs can further advance underserved students' exposure to advanced science activities has emerged. Underserved students need to feel a sense of belonging in the scientific community and through supplemental programs students have gained experiences in science that promoted interests, motivation, and confidence to do science. As a result of these experiences students can potentially gain a science identity as they navigated from one experience to the next in science (Settlage et al., 2009).

Through examining how students perceive these science experiences and their relationships to science, science learning, and their pursuit of science postsecondary majors and careers, this phenomenological study helps to explain how underserved students formed strong science identities.

Chapter 2

Theoretical Framework and Literature Review

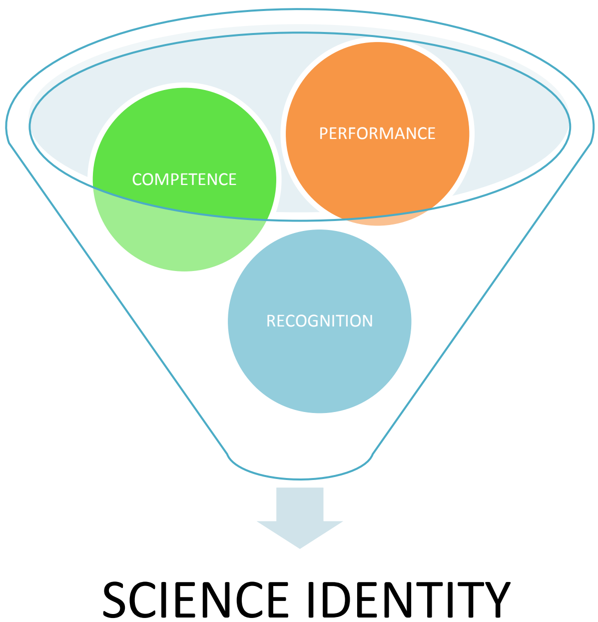
This chapter provides an overview of the theoretical framework, science identity theory (Carlone & Johnson, 2007), and a discussion of the research literature providing an historical overview of science education and its influence on science learning, achievement, and science identity formation for underserved students. Additionally, a review of the research literature focusing on the influence of science instruction, supplemental science programs, and culture and family on science learning and science identity formation in underserved students was conducted.

Science Identity Theoretical Framework

When underserved students gain knowledge, competence, and meaning from their participation in science, they form a science identity in relation to those lived experiences and social interactions that occurred in their learning communities. Joining groups with shared interests in science facilitates science identities as a result of commonalities they share among other members of the group. These interactions with diverse peers in the classroom and in supplemental instruction and programs plays an important role in increasing an underserved student's interest in science, and postsecondary science majors and careers (Ferry, Fouad, & Smith, 2000). Furthermore, setting high expectations for underserved students influences their attitudes, motivations, confidence, competence, and abilities to perform science, as well as stresses the significance of enriching science instruction in a learning community (Ferry et al., 2000). Through shared common interest with peers in science, students' interests in science and visions of themselves as future scientists emerged (Stake & Nickens, 2005). These social interactions with peers in supplemental learning communities help embed the belief that science has value and that all students are capable to engage in the sciences. Bandura (1997) noted being influenced by these interactions also helps an individual determine the viability of their identities and aspirations as they relate to their peers. Science identity theory encompasses a social component, which explores and advances a deeper understanding of the interactions that occur in group and intergroup relationships, as well as explains the individual and group values and norms that can occur in educational learning communities (Tajfel & Turner, 1979; Carlone & Johnson, 2007, 2012). Subsequently, the exploration of the lived experiences of students' participation in a supplemental science program and its influence on science identity formation in students was a warranted study.

Science Identity Defined. Building identities in science fostered very early in a child's education prompts engagement and interest in the sciences well into adulthood. Carlone and Johnson (2007) developed a science identity model to explain how students gain an understanding of the world scientifically through engaging in meaningful scientific activities. The science identity model encompasses science knowledge, understanding, and skills in scientific practice that promotes the perception of oneself as a science person through three interconnected characteristics of "competence, performance, and recognition" (Carlone & Johnson, 2007, p. 1190). For example, students are more likely to advance their science knowledge and skills, and form identities in science when exposed at a very young age to experiences and opportunities in science. As previously stated, a person with a science identity is defined as (1) one who demonstrates meaningful knowledge and understanding of science content, (2) motivated to understand the world scientifically, (3) acquires skills in scientific practice, and (4) sees oneself as a science person (Carlone & Johnson, 2007; Gee, 1999). These identity characteristics were found to be crucial to one's overall development in science. Furthermore, a science identity continuously develops overtime as a student acquires knowledge in science by doing science in the learning environment (Carlone & Johnson, 2007, 2012). The following educational research literature helps explain the influence science education, activities, and opportunities had on students' identities in science. Figure 1 displays the interconnected characteristics merge into forming a student's science identity.

Figure 1: Science Identity Interconnected Characteristics



Science identity formation process. Student science identities develop significantly overtime, starting in elementary and middle schools. Educational, cultural, and social experiences influence students' science identities. In a study conducted by Carlone, Scott, and Lowder (2014), which is a part of a larger longitudinal study (NSD #REC0546078), identity development, was evaluated in three diverse students in school science in fourth and sixth grades. The science identity formation process is largely influenced by the instructional content, culture of the learning environment, and expectations in science, as it relates to student identity work. Carlone and colleagues (2014) noted, observational data and video recordings of the three students in the study revealed that a learning environment rooted in identity work that sets the expectation of "being scientific" facilitates science identity development. For example, a learning environment that encourages students to ask questions, conduct observations and experiments, and draw conclusions in science through doing science promotes science identity formation in students. Furthermore, students are highly concerned with how they see themselves as a science person, as well as how they are viewed by their teachers and peers in science (Carlone et al., 2014).

Ultimately, teachers set the tone for the overall science experience for students, and when students encounter positive experiences in science, they can see doing science as an interesting and rewarding experience. Thus, each of the students came to see themselves doing science. Through teacher-student interactions in school science Carlone and colleagues (2014) stated, "students come to understand that being a "good" and "smart" science student meant thinking critically, persisting, problem-solving, and making unique observations, as well as creating scientific explanations and also being empathetic to nurturing with peers" (p. 858). Specifically, "being scientific" was intertwined with what each individual student intended to be. However, as the three students progressed to the sixth grade, the intersection of race, class, and gender was found to play a significant role in science identity work and development in the three students. For example, outspoken behavior that was viewed as a positive trait in the learning environment by the fourth grade teacher was viewed negatively by the sixth grade teacher as attention-seeking or the "loud Black girl" (Fordham, 1993), which diminished her identity work in science. In contrast, the other two students remained connected to building a strong identity because they received consistent and positive support from their fourth and sixth grade teachers. Ultimately, the learning environment needs to embrace the individual needs of students and not support bias determinations based on the race of a student, which can hinder science learning and the development of students' identities in science (Carlone et al., 2014).

Science identity for underserved students. Learning mathematics and science in earlier grades is essential to identity construction in students. Varelas, Martin, and Kane (2013) examined content learning and identity construction (CLIC) in Black students attending a low-performing school. Historically, teachers have been found to make assumptions about Black students enrolled in low performing schools by thinking they are not prepared for science learning, and frequently believe their behaviors can be disruptive and counterproductive to learning. While observing the identity construction of a Black male first grade student, as he engaged with his science teacher, Varelas and colleagues (2013) found the Black first grader was able to explore his own views, ideas, and questions about the world of science through engaging in teacher directed science inquiry and student/teacher discovery and dialogue. For example, science identities are based on who the student believes they are to be at a specific point and time in science, as well as how they learn and achieve in science. Subsequently, Varelas and colleagues (2013) stated, "identities are lenses through which we position ourselves and our actions, and through which others position us" (p. 6), and Black and Latino students have racial, academic, and disciplinary identities that come together as they attempt to engage and make sense of science practices. For example, underserved students who experience ongoing engagement in science with positive role models, such as teachers, mentors, peers, and science professionals, can empower the application of science knowledge and practices in their lives. Recommendations from the wealth of research suggests that "ongoing engagement with ideas about identity construction offers students the opportunity to examine and share their sense of self, revisit it, rebuild it, revise it, by responding to both the cumulative and the at-the-moment experiences in the classroom" (Varelas et al., 2013, p. 14). To contribute to the wealth of science identity research, this evaluation helped explain the influence these science learning activities and relationships had on forming students' science identities.

Interventions to support science identity formation. Science achievement correlates with positive attitudes toward science and a keen interest in science. Spiegel, McQuillan, Halpin, Matuk, and Diamond (2013) utilized a novel research approach by evaluating the influence comics and graphic novels/stories had on science education in teenagers. In recent years there has been an increased interest in comics featuring science, history, biography, philosophy, mathematics, and various forms of fictional content (Hosler & Boomer, 2011; Hosler, 2000). Two different comics and graphic essays focusing on a distinctive viruses developed by the National Institute of Health were randomly distributed to the students to determine the impact of the comics in comparison to essays on science interests and learning. Surveys were administered to ninth and tenth grade students enrolled in 15 biology classes in six public high schools in the Midwestern US to discern the science identity factor which measured their interaction with the reading materials. Overall, the study found there was a significant relationship between science identity development and the materials assigned. In the comic group, low science identity students were more apt to continue reading materials about viruses, which is the same as in the essay group of high science identity students. Given the brief intervention, comics were found to be an effective tool for teenagers with low science identity who were less likely to read about science in the essay format. This study supports the idea that relevant and relatable science resources can increase student interest, thus promoting positive identities in science.

Student interest in science plays a significant role in students' pursuit of postsecondary majors and careers in the sciences. Many factors contribute to the career path students may take when transitioning from high school to college or high school to work (Tyson, Lee, Borman, & Hanson, 2007; Bandura, 1993. Underserved students with limited exposure to science may have diminished knowledge and commitment to science, thus choosing science postsecondary majors and careers are unlikely (Tyson et al., 2007; Martinez, 1992). In the Pacific Crystal Centre for Science, Mathematics, and Technology, an evaluation of the influence science learning had on identity, and career planning for secondary students was conducted (Guenette, Lawrence, & Fisher, 2011). Through an evaluation of the interview transcripts, Guenette and colleagues (2011) found high school seniors interviewed expressed they needed knowledge of science skills and processes in order to establish a clear career path in science. Furthermore, the students noted that their own self-efficacy in science strongly influenced how they engaged in science. For example, students exposed to science education that builds not only science content knowledge, but helps them connect this knowledge to potential career pathways and future careers, are able to gain skills and knowledge, and establish goals and priorities for effective decision making (Guenette et al., 2011). Subsequently, through integrating real world experiences in science education, an exploration into one's science identity and personal identity helped adolescents navigate the postsecondary and career pathways more smoothly.

K-12 Science Education a Historical Perspective

For many years, concerns were raised about the ability of the U.S. educational system to provide science instruction to underserved students (Geier, Blumenfeld, Marx, Krajcik, Fishman, Soloway, & Clay-Chambers, 2008). Educational research has found that limited resources, opportunities, and exposure to science activities in schools reinforced underserved students' struggle with finding science relevant and relatable to them (Barton, 2002). Underserved students have lagged behind their peers academically as a result of limited resources and opportunities to engage in the sciences (O'Connor, Hill, & Robinson, 2009; Paolini, 2015). The inconsistencies in the development and implementation of science policies, curricula, and programs in schools for a high percentage of underserved students, has potentially contributed to significant challenges when students seek to build science identities (Fenning & Rose, 2007).

Science identity development helps produce a way for students to move from one experience to the next experience in science (Settlage et al., 2009). The science identity model developed by Carlone and Johnson (2007) shows how students can gain meaningful knowledge and understanding of science that motivates an understanding of the world scientifically, and helps gain scientific skills and confidence as a science person. Therefore, this literature review covers science identity formation through an evaluation of the history of science policies, curricula, and instructional practices as it relates to science learning and achievement, and the social/cultural and supplemental instructional influences on underserved students in science.

Science Resources– A Historical Perspective Early 1900s

Since the early 1900s, science education has been concerned with how to best connect people to the world of science. Science teaching became a part of the K-12 curriculum in the early

19th century largely due to the influence of scientists, such as Thomas Huxley and Charles Lyell (DeBoer, 1991), and the writer Melville Dewey (Johnston, 2013). In the early, 1900s, the Commission on the Reorganization of Secondary Education (CRSE) of the National Education Association science committee report, *Reorganization of Science in Secondary Schools* (*RSSS*) (National Education Association [NEA], 1918, 1920) recommended that applying scientific knowledge and skills relevant to the activities of life, through the inclusion of inquiry science, should become a part of the school curriculum (Johnson, 2011). The *RSSS* was important because of its promotion of "the application of scientific knowledge to the activities of life" and "the demands for a logically organized science" (NEA, 1918, p. 8). As noted by DeBoer (2000), K-12 science education in the early 1900s was "justified more and more on the basis of its relevance to contemporary life and its contribution to a shared understanding of the world on the part of all members of society" (p. 583).

Although the core of *RSSS* proposed opportunities for students from diverse backgrounds and socioeconomic statuses to gain science knowledge and form an identity of themselves as scientists, these opportunities were not afforded to Black students in the 1900s because of the prevalence of racism and Jim Crow laws that marginalized Blacks. Because racism and Jim Crow laws disenfranchised Black students and reduced opportunities for Black students to gain science knowledge and identity (Alridge, 1999), many Black leaders during the 1900s, such as Dubois (1902, 1968) and Booker T. Washington (Alridge, 1999) proposed an educational agenda for Black students. Alridge (1999) noted that, "Dubois advocated for Black students to have training and knowledge in liberal and classical education (the sciences, history, political science, economics, law, and other professional fields)" and that education should be viewed as "the most expedient means of bringing about democracy for Negroes during the early 1900s" (p. 185). Additionally, in the early twentieth century, Booker T. Washington recommended the inclusion of vocational and educational training. Nevertheless, the marginalization of Blacks resulted in insufficient government funding and resources for Black schools; thus, serving as a counter measure to the *RSSS* by limiting students' access to equal and effective opportunities to learn science and other disciplines.

Science Resources– A Historical Perspective 1940s to 1990s

In the 1940s, 1950s, and 1960s, the world of science within the context of world affairs was the shifting focus. During the 1940s, the US was more concerned with post World War II recovery and the ever-growing Black's demand for full citizenship and equality (Berry & Bassingame, 1982). In response to these demands, the National Society for the Study of Education report, *Science Education in American Schools* (National Society for the Study of Education [NSSE], 1947), revisited *RSSS* policies and curricula in order to make the curriculum clearer, more functional, and easier to implement for all students in schools. In the 1950s, the Supreme Court's 1954 *Brown v. Board of Education* decision to integrate schools brought a level of hope for Blacks; however, DuBois feared that poorly planned strategies to integrate schools would exacerbate problems of psychological oppression and identity struggles, thus reinforcing limited exposure to educational opportunities for Blacks (Alridge, 1999). Furthermore, Tate (2001) noted that the opportunity to learn mathematics and science was a civil right, but counters traditional desegregation perspectives of racial inequality. Because Blacks were transferring from Black to White schools post segregation, Black schools became even more under-resourced which resulted in a significant reduction on professional learning grounded in advanced technical and industrial skills (DuBois, 1968). Thus, an unintended consequence of desegregation was that the learning gap between underserved Black students and their peers in advanced schools was perpetuated along with diminished identities in science.

Sputnik and science education. To further advance science education in the late 1950s and 1960s, Soviet Sputnik space exploits encouraged massive reforms led by scientists in U.S. schools. The line was drawn between science and technology, which resulted in a shift to teaching science through conducting open-ended laboratory work (Yager, 1996). Furthermore, the climate in the early 1960s to the mid-1970s encompassed integration issues and the Vietnam War, which contributed to society blaming science for the political, societal, and environmental woes of the times (Yager, 1996). To address these issues, *Project Synthesis* examined science education by reviewing research funded by the NSF and the results of the 1977 National Assessment of Educational Progress (Harms, 1981). *Project Synthesis* made an effort to develop broad goals or the project term 'goal clusters' that led to student objectives useful to driving educational policy. A consortium of 23 science educators separated into five subgroups focusing on elementary science, biology, physical science, inquiry science, and the influences of science, technology, and society (Yager, 1993). Overall *Project Synthesis* stressed the role of science education to prepare students to use science to improve their lives, to cope with an increasing technological world, and to become responsible and informed citizens prepared to address science-related societal issues (Harms, 1981; Volk, 1984). For example, science education allowed students of varying aptitudes and interests in science to acquire appropriate science knowledge that fostered awareness of the broad scope of careers in science and technology that was available to them. Although *Project*

Synthesis was promising for schools, teachers were concerned that most of their colleagues depended mostly on textbooks and had limited creativity, and that the goals of *Project Synthesis* were vague and lacked pre-designed lessons for use in science classrooms (Harms, 1981). Thus, the potential for *Project Synthesis* to increase science learning for underserved students was inadequate because of the "problems in science education which include inadequate facilities, lack of resources and money, lack of time for adequate science instruction, and teachers' lack of knowledge, and the poor preparation" (Czerniak & Chiarelott, 1990, p. 49; Harms & Yager, 1981; Weiss, 1978, 1987).

Global competition and science education. In the 1980s, the current economic instability caused by the perceived supremacy of Japan, Germany, and other industrial nations over the US consumed the political and educational climate (Yager, 1996). This instability resulted in a shift away from producing a diverse population of future scientists through providing science pedagogy, diverse curricula designs, and culturally teaching and instruction, to a cognitive science approach which primarily focused on how human beings learn (Giere, 2010). As a result of the limited diversity in science professions, the US was ill-prepared to meet the demands in the global marketplace in science (Anderson, 2002). In response to these issues, *Atlas for Science Literacy: Project 2061* (American Association for the Advancement of Science [AAAS] & National Science Teachers Association [NSTA], 2007), encompassed the *Benchmarks for Science Literacy* (AAAS, 1994a), and *Science for All Americans* (AAAS, 1994b), which provided standards in science, mathematics, and technology, grounded by literacy goals (Anderson, 2002). These standards attempted to aid students in understanding how scientific endeavors work in order to empower their view of the world of nature and their roles in it, grasp concepts in science, mathematics, and technology, and acquire ways of thinking in order to become inquisitive and critical learners and thinkers through hands-on activities in the laboratory and the field. However, *Project 2061*, which stressed high achievement and learning for all students through real world experiences in science, lacked a focus on providing educational equity for all students (Anderson, 2002). Students in under-resourced schools were not exposed to real world experiences in science because of school-based issues, such as less-knowledgeable science teachers, and limited or nonexistent opportunities to engage in laboratory work and field experiences, which could be attributed to limited funding sources. Hence, because of limited exposure to real world science experiences and opportunities, science identity development for underserved students continued to be elusive.

Science Resources –Historical Perspective 2000 to Present

During the 2000s to the present, educational equity determined by resources and opportunities provided to students in schools, influenced what science counts as well as what science should be taught in schools (Lee, 2003, Lee & Butler, 2003). Labov (2006) established that science education in the US has been at a crossroads, and as a global leader, the US is losing their footing in the development and use of science and technology. President Clinton's, *Goals 2000: Educate America Act* (Goals 2000) provided funding, direction, and leadership in a decentralized education system (Schwartz & Robinson, 2000). *Goals 2000* challenged traditional teaching methods that focused primarily on science facts and content by providing standards and resources found to improve science teaching to facilitate student connections to content knowledge, culture, community, and identity in relation to science (Labov, 2006).

However, the reality is that underserved students were not equipped to engage in the sciences because of limited exposure and resources. The main goal in science education was to “equip students with the knowledge and skills necessary to think critically, solve complex problems, and succeed in the 21st century society and economy” (Finn, Kraft, West, Leonard, Bish, Martin, Sheridan, Gabrieli, & Gabrieli, 2014, p. 1). In spite of this goal, underserved and minority students still achieved below their White and middle/upper middle-class peers as a result of the high significance that is placed on standardized test scores as a primary indicator of real learning in students (Chronicle & MacGregor, 1998). In a study conducted by Good, Aronson, and Inzlicht (2003), a pattern of underachievement for Black and Hispanic students was reflected in standardized assessments in comparison to White and Asian students. Underserved students were found to feel academically vulnerable to underperform, and were influenced by the negative associations they made to their social identities and personal identities in the school environment (Tajfel & Turner, 1979). For example, these negative identity associations undergirded mediocre performance on standardized tests, which did not accurately reflect students’ science knowledge because of their stereotypical preconceptions and group associations (Galinsky & Moskowitz, 2000). Furthermore, Good and colleagues (2003) and Tinto (1993) stressed the significance of psychological factors, such as teacher expectations, where teachers established a deficit model of low expectations for underserved students, which can be attributed to negative performance outcomes because of underlying racial and cultural stereotypes that disputed underserved students’ abilities intellectually and academically.

As a result of negative performance outcomes, President Obama’s *Educate to Innovate* (ETI) initiative was introduced in November 2009, with the overall goal to move students from all backgrounds from the bottom ranking to the top worldwide in science and mathematics by providing standards in the fields of science, technology, engineering, and mathematics (STEM)

(Burke & McNeil, 2011). *ETI* attempted to 'plug the leaky pipeline' perpetuated in an educational system plagued with significant challenges for underserved students pursuing STEM education (Blickenstaff, 2005; Burke & McNeil, 2011). Burke and McNeil (2011) conducted an evaluation of the 'one-size-fits-all' approach presented in *ETI*. Although key components of *ETI* included imposing national science standards and assessments, and increasing teacher workforce by 10,000 new knowledgeable science teachers over the next five years, statistics revealed that only 2,500 more science teachers were currently being trained pointing to the growing issue of less-knowledgeable science teachers, especially in under-resourced schools (Burke & McNeil, 2011). For example, teachers with limited knowledge of science content and content standards diminishes science learning for underserved students who have faced a multitude of academic and social issues in- and outside-of-school. Furthermore, critics were concerned that a standards-based approach may promote "standardization of mediocrity," and a "blanket approach to education reform which undermines innovation in STEM education; thus, increasing conformity at the expense of meeting the diverse needs of students" (Burke & McNeil, 2011, p. 4). Consequently, *ETI* presented challenges when addressing diverse populations of students, but did nurture interest in the sciences for students at an earlier age and helped construct identities in science to support a solid STEM-educated citizenry (Burke and McNeil, 2011).

Science Standards and Science Education

Standards-based reform continued in the 2000s through the reauthorization of the Elementary and Secondary Education Act, *A Blueprint for Reform* (United States Department of Education, 2010), and the federal *Race to the Top* (Higher Education Research Institute, University of California Los Angeles [HERI/UCLA] ,2010) competition for funds required states to adopt the national *Common Core State*

Standards (CCSS). CCSS was developed by a multistate consortium, and encompassed standards in reading and mathematics, and Literacy in History/Social Studies, Science, and Technical Subjects (CCHST) (Yarden, 2009). Porter, McMaken, Hwang, and Yang, (2011) compared current state standards, student assessments, and best teaching practices from a sample of teachers and students from across the country. The study found that the CCHST were never meant to be science standards; rather, they were literacy standards to promote literacy skills and support understanding concepts in multiple disciplines. The CCHST lowered existing, inadequate science standards currently in place in schools, and placed a requirement for students to be proficient readers in order to gain knowledge from texts and to demonstrate a careful understanding of what they read in all the disciplines (Porter et al., 2011). The CCHST significantly shortchanged learning for students in favor of creating lists of testing items in science assessments, as well as ignored essential science content, expected students to know specific science knowledge in later grades it hadn't required teachers to teach in earlier grades, emphasized routines and activities rather than actual knowledge, and stifled essential science-related math (Porter et al., 2011). For example, reading proficiency was the cornerstone of CCSS and CCHST, but when underserved students enter elementary school, they already exhibit reading proficiency issues, which can significantly impact learning and achievement in elementary, middle, and high school (Colker, 2014). For example, reading proficiency statistics from the 2013 National Assessment of Educational Progress (National Research Council, 2013) reflected that only 16 percent of Black, 23 percent of Hispanic, and 26 percent of American Indian twelfth graders were at or above the reading proficiency level.

Next Generation Science Standards and Science Education

In response to the current *Common Core Science Standards*, the *Framework for K-12 Science Education* (National Research Council [NRC], 2012; Next Generation Science Standards [NGSS], 2013) was developed to address the growing concern with the current approaches in K-12 science and the nation's reading proficiency problem. Although the absence of enriching national standards in science that can effectively prepare students for a science and technological in the global economy, the National Research Council (NRC, 2012; NGSS, 2013) noted that the 2000s have emerged as an exciting time for K-12 science educational reform in the US, and was the motivation for the recently released *NGSS*. The *NGSS* recommended an emphasis on classrooms that bring "science alive" for students by investing in a blend of science content knowledge that encompassed core ideas, crosscutting concepts, and various practices, activities, and/or applications that can be conducted individually and/or in cooperative learning groups (Porter-Magee, 2013). For example, *NGSS* promoted opportunities for all students to engage in real-world science that was relatable and relevant to them. Although opportunities to engage in real-world science can be significantly impactful for underserved students with limited exposure to the world of science, challenges emerged for students that had limited literacy proficiency (Bell, Blair, Crawford, & Lederman, 2003; Porter-Magee, 2013).

The *NGSS* was developed by teachers, administrators, and educational leaders in 26 lead partner states. Although initial support for *NGSS* from key partners, educators, and political leaders was significant, currently, *NGSS* has only been adopted by 16 states, which diminishes its impact on the larger population of students in the US. *NGSS* can benefit students by encouraging them to think like scientists through a three-dimensional instructional shift from simply telling students information they need to know to students figuring out information (Mathewson, 2017). However, an implementation obstacle of *NGSS* was that it was a significant departure from the way science had been taught in schools in the past. Porter-Magee (2013) noted that NGSS placed critical content secondary to subjective and outlying activities, such as critical reading and oral presentation, which counters traditional science teaching methods. Furthermore, *NGSS* imposed a rigid format dominated by recommended practices rather than critical content, which impeded students learning key content integral to building a solid science foundation. In other words, the implementation of *NGSS* should have been a balance between content and practice in order to promote science learning in students. Porter-Magee (2013) contended that *NGSS* was expansive in nature and posed significant implementation challenges for teachers not properly trained in this instructional approach. Furthermore, as a result, schools/school districts, scientists, school administrators, teachers, and curriculum specialist were concerned that underserved students may not experience the full benefits of *NGSS* due to lack of government funding and policies to encourage the adoption of *NGSS* and the multitude of training challenges (Porter-Magee, 2013).

Underserved students are experiencing the ‘leaky pipeline’ perpetuated in the U.S. educational system which continues to pose significant challenges for underserved students pursuing STEM education (Blickenstaff, 2005; Burke & McNeil, 2011). In response to this ‘leaky pipeline’ the U.S. educational system has consistently worked to improve science education through a series of policies, initiatives, and standards-based reforms, with the overarching goal to increase student engagement in the sciences. However, underserved students continue to fall significantly short of achieving the overarching goal in science because of the perpetuation of a culturally devoid ‘one-size-fits-all’ approach to science education (Lynch, 2001; Burke & McNeil, 2011), and thus continue to experience disparities in science learning and diminished identities in science.

Science Teaching

Science instruction. Science instruction has been found to positively influence the success of students. To counter the focus on learning facts and content, the re-emergence of inquiry-based instruction guided by standards-based reform was perceived to be cognitively beneficial for students coming from low socioeconomic and culturally diverse backgrounds (Gay, 2010). Through inquiry-based instruction, students learned how to formulate questions, collect and connect relevant facts and information, look at science in a new way, and share their new knowledge with others. In a study conducted by Minner, Levy, and Century (2010) and also noted in a study by Anderson (2002), an investigation of inquiry-based science instruction and reforms from 1984 to 2002 were found to be beneficial to science learning and identity development when implemented effectively. However, limited professional development for teachers posed significant challenges for the implementation of inquiry-based instruction in schools. Consequently, underserved students were not exposed to science learning because of these challenges, especially in schools with less-knowledgeable teachers. Additionally, substantially limited school resources were found to be significant contributors to diminished science learning and science identity formation in students (Gay, 2010; Lee, 2003; Lee, Hart, Cuevas, & Enders, 2004). Although the National Science Education Standards (National Research Council, 1996) attempted to provide a roadmap to guide teachers through the inquiry-based instructional approach in science, the majority of teachers were overwhelmed with implementing the inquiry approach as a result of limited professional training and inconsistent school-based support, especially in schools with a high percentage of underserved students.

A significant aspect of science instruction is how well the teacher knows the students (Crawford, 2000; Kagan, 1992). Teachers can facilitate a student's ability to gain, build, and create new knowledge in science through providing equal access to learning opportunities that construct and expand on what students already know. Buck and Cordes (2005) found that teachers' predispositions and biases encouraged historical and cultural misconceptions about groups other than their own, and these misconceptions were negatively shaping instructional practices in the classroom (Banks, 1991; Bullock, 1997; Feiman-Nemser, 2001; Zeichner, 1993). Teachers who participated in professional development to review, study, and explore their own images, beliefs, knowledge, and experiences when teaching science were able to develop skills to effectively meet the needs of underserved students (Feiman-Nemser, 2001). For example, a more progressive instructional practice was for teachers to sort out difficult situations that occur in the classroom through self-reflecting on how their own biases potentially impacted instructional practices. Through self-reflection, teachers became research-based educators who made instructional modifications that enhanced science learning and success in students (Buck & Cordes, 2005; Feiman-Nemser, 2001).

In under-resourced schools, Anderson (2002) recommended that teachers should concentrate on what works in their classroom rather than being initially burdened with theory and practice. The inclusion of theory and practice in the process of teachers acquiring science instructional practices is significant, but should be addressed in conjunction with considering teachers' current science knowledge, instructional practices, training, and beliefs in association with the abilities of the students they teach. Anderson (2002) noted in under-resourced schools teachers frequently lack sufficient resources and training, and may feel isolated; thus, engaging in science instruction reflective of robotic lessons that are based solely on textbooks with no significant connections to the needs of students or to the real world of science. In contrast, teachers who focused on instructional practices relating to real world science that meets the needs of their students, and made appropriate adjustments and changes to lesson presentations and activities promoted science knowledge building for students. Furthermore, teachers who adapted science pedagogy by shifting their focus to the nature of student work, student roles, and their roles as teachers in the science learning environment facilitated student connections to the world of science (Anderson, 2002). However, without these types of instructional practices, underserved students were found to be less likely to engage in learning and may have experienced limited exposure to science knowledge and skills, which is necessary for identities in science.

Helms (1998) noted that science pedagogy was also found to strongly influence science instruction. When science teachers engage in a community of practice (Lave &Wenger, 1991a), they are able to view their instructional vision. According to Helms (1998), science instruction should not be a series of terms and definitions presented by the teacher, rather, instruction should be driven by science content knowledge that promotes awareness, responsibility, and relevance to each student through engaging in multiple learning activities directed by knowledgeable teachers. For example, teachers who provided science activities where students were able to engage in developing their own scientific questions were found to help build personal views of science, gained a better understanding of the world, and designed real science lessons that were relatable, and relevant to their students (Ratcliffe & Grace, 2003; Lawson, 1989). In addition, teachers who recognized the connections that exists between student values, actions, belief, social interactions, and science subject matter facilitated student learning in science and helped them apply this knowledge in their own lives (Helms, 1998).

Science is increasingly perceived as a social learning experience while the science laboratory is the effective social learning setting (Hofstein & Lunetta, 2004). Students can work cooperatively in the laboratory setting to explore scientific phenomenon that helps them connect science content to the real world. For example, in the laboratory setting, teachers facilitate a hands-on environment where students can gain laboratory skills by developing and conducting experiments. If used properly, laboratory work in science courses have been found to be fundamental to promoting student learning in K-12 science education, and helps build positive perceptions, attitudes, and interests in science (Hofstein & Lunetta, 2004). Although laboratory investigations were viewed as an essential instructional practice, “laboratory inquiry alone has not been sufficient to enable students to construct the complex conceptual understandings of the contemporary scientific community” (Hofstein & Lunetta, 2004, p. 32-33). Teachers also need to know their students ability levels and utilize multiple instructional approaches in science, and laboratory work. A significant obstacle that teachers faced in the laboratory was the lack of laboratory resources and training in laboratory skills, which resulted in teachers becoming too consumed with laboratory procedures and calculations that minimized the science content to be covered (Hofstein & Lunetta, 2004). Consequently, because of the lack of high-quality instruction in the science laboratory, students formed negative perceptions of laboratory work.

Science training. Teachers are critically important to the success of education since they directly impact student learning outcomes. Science teachers encompass a multitude of roles, such as classroom educators, college faculty, student mentors, and science professions. Science education reform efforts have shifted much of its focus to improving teacher quality through professional development efforts (Lumpe, Czerniak, Haney, & Svetlana Beltyukova, 2012). Lumpe and Colleagues (2012) conducted a study of the impact of a large-scale professional development project on science teaching and student learning outcomes. The study evaluated the collaborative partnerships between K-12 schools and universities that utilized the science and mathematics professional development model designed by Loucks-Horsley, Love, Stiles, Mundry, and Hewson (2003). The professional development model trained teachers to initially evaluate their own personal beliefs about science, student learning, and diversity/culture, and how these beliefs can negatively or positively influence the classroom environment, while also impacting student interests, learning, and achievement in science. When teachers objectively reviewed their goals, plans, and actions in the science classroom environment, they were more prepared to make positive connections to science teaching and student learning (Tilbury, 1995; Villegas & Lucas, 2002). For example, underserved students and teachers may not share similar beliefs and this should be taken into consideration when designing the classroom environment. Therefore, professional development was designed to help teachers channel their beliefs toward a positive trajectory. Overall, findings of Lumpe and colleagues (2012) reflected that teachers who participated in long-term professional development programs (100 hours across one year) made positive changes in their science teaching by creating a learning environment promoting student learning and achievement.

How teachers instruct their students was as equally important as the science content they were required to teach. Through an identity lens, Luehmann (2007) evaluated the impact of science teacher preparation programs which fostered a reform-minded science identity in teachers in order to benefit students. A teacher's identity was viewed as equally important as the identity of students in science, and it should be developed in order for teachers to model and instruct students in a viable, relevant, and relatable manner. All teachers and students have a core set of identities that are uniquely their own, and when teachers shifted to a reform-minded identity, diverse students potentially gained new science knowledge and skills that were very different from what they would normally experience in school (Luehmann, 2007). Reform-minded science teaching required extensive long-term professional development that fostered content knowledge, attitudes, and opinions in teachers. However, implementation in schools had significant challenges because of limited resources and personnel to support teachers through the process (Luehmann, 2007).

Underserved students need teachers to nurture attitudes or habits of mind through science activities that build competence, skills, and self-confidence in science at a very early age (Banchi & Bell, 2008). Teacher professional development programs were needed to do a better job at providing training in science inquiry-oriented practices that foster knowledge and confidence in science for students (Banchi & Bell, 2008). For example, science teachers who were trained in science inquiry-oriented practices recognized the social component of science and were found to embrace scientific discovery and cooperative discussions among their students in science (Lazarowitz, & Karsenty,1990; Yore, Bisanz, & Hand, 2003) In addition, when teachers facilitated students' examinations and evaluations scientifically, both teachers and students gained a level of participation academically and socially at the confirmation, structural, guided, and/or open inquiry levels in scientific endeavors. Through these social learning experiences, students were found to gain a stronger footing in science that promotes science identity overtime (Banchi & Bell, 2008).

School, Family/Community, and Cultural Influences in Science

School Culture and Resources in Science

The lack of support for the institution of standards and policies linked to school-based funding has presented significant obstacles for schools serving a high percentage of underserved students. As a result of counterproductive support maintained by school leaders, teachers, and peers who are concerned with ‘‘who belongs’’ or who gains access to enriching science activities and programs (Olitsky et al., 2010) has infused in students negative views of one’s self and the world while posing obstacles for students in learning science. Teachers utilizing dialogic instructional practices in order to create a classroom structure conducive to learning science for all students were explored by Olitsky and colleagues (2010). The data analysis revealed that building a classroom community grounded in science content, which is relevant and relatable to students, was found to facilitate a learning experience centered on students being contributors and receivers of knowledge (Lave & Wenger, 1991b; Olitsky et al., 2010). For example, by creating a classroom culture of cyclical learning, both teachers and students engaged in science activities and discussions where they can be a contributor and/or a receiver of science content. As a result, all members were better able to connect science content to the real world. Overall, Olitsky and colleagues (2010) noted the need for teachers to foster a classroom culture where the learning process garners student participation as contributors and receivers of science knowledge, which empowers social capital in students. Furthermore, as students participate in a cyclical learning experience, they became social learners more engaged and vested in science in the classroom environment, in the field, and in their community.

Historically, there has been limited endorsement of socially and culturally unbiased science education in urban schools, but gradual changes are currently taking place according to Buxton (2005), who directed a study spanning three years at the Center for Science and Math (CSM). CSM was an urban magnet science, math, and technology high school founded on an institutional school culture model of academic success for underserved students who would normally not experience opportunities in science education. The established school culture model addressed issues of diversity and identity, in collaboration with high academic expectations for students (Buxton, 2005). Through the negotiation of school, family, neighborhood, and peer group identities, students were found to constantly maintain several identities in the course of a day (Buxton, 2005; Kozol, 2000; Tajfel, 1982a); thus, the implementation of the school culture model enabled students to expand and grow their identities as a result of their experiences at CSM. For example, under-resourced school leaders have to make a conscious effort to recruit and hire energetic science teachers and staff that share the school's culture model. CSM's culture model of high academic expectations and acceptance of diversity helped build the school community of students, teachers, staff, parents, and administrators that embraced high expectations and diversity. Buxton (2005) found that CSM's school culture model was a significant gauge of student success for those students who bought-in to the culture model belief system. However, some challenges did exist for students coming from under-resourced schools with low academic expectations. They struggled with buy-in to a counter school culture model of high expectations; thus, more work was needed to guarantee all students would see themselves meeting those expectations (Buxton, 2005).

A study conducted by Hammond and Brandt (2004) examined the science classroom culture and the social, cultural, political, and historical influences that exist in science education.

Through the review of research articles in two major science education journals spanning ten years: *The Journal of Research in Science Education* and *Science Education,* the study found that race, ethnicity, socioeconomic status, and gender of students influenced learning for underserved students. Hammond and Brandt (2004) established "multi-science" that focuses on indigenous reflections of the world, which was found to significantly impact the way students view themselves doing science. Historically, the traditional approach in science has been devoid of culture and science exposure and educational opportunities were mainly earmarked for those of the dominant and privileged, Western culture (Hammond & Brandt, 2004). For example, teachers traditionally approached science instruction through a series of topics, terms, and definitions to be applied to in-class activities that were rarely connected to students' real world experiences. Therefore, students' abilities to connect what they do in science to what they may be experiencing in their lives, cultures, and communities are inhibited.

In attempts to enmesh home cultures and the culture of science in schools, more equitable and inclusive curricular approaches for diverse underserved student populations should be employed (Brown, 2004). Science learning has been a culturally urbane process. Brown (2004) conducted an analysis of students' individual assimilations, their experiences, and the home, community and cultural conflicts that occur in the classroom. For example, in numerous cultural spaces, students maintain dual membership, and bring unique ways of prompting their social identities and individual identities in the classroom (Brown, 2004; Tajfel, 1982a). In an effort to accomplish various genera in the science classroom, students need to develop and shift identities. Through examining a student's assimilation into the science classroom, Brown (2004) recommended that science teachers, scientists, and researchers need to engage in dialogue with culturally diverse student populations that prompt beneficial and equitable learning experiences and exchanges in the classroom. Subsequently, Brown (2004) noted the importance of teachers to foster cultural acceptance for all students that encourages participation in science activities and discussions, as well as the application of science knowledge in various undertakings.

Family and Community Influences in Science

Engaging students in science education grounded in native communities is a growing practice in education (Bell, Lewenstein, Shouse, & Feder, 2009). Multidisciplinary research has found that underserved students need to understand and be aware of how their different backgrounds affect their education and their ability to navigate in diverse settings (Milem, Chang, & Antonio, 2005; Stephens, Hamedani, & Destin, 2014; Denson, 2009; Gurin & Nagda, 2006; Gurin, Nagda, & Zuniga, 2013). Science education has often failed to recognize the connections between the science and culture. The environment in which a student is raised and the attitudes of their caregivers significantly influence a student's development greatly (Mack, Augare, Cloud-Jones, David, Gaddie, Honey, Kawagley, Plume-Weatherwax, Fight, Meier, Pete, Leaf, Scout, Sachatello-Sawyer, Shibata, Valdez, & Wippert, 2012). Academic benefits were found through an examination of effective practices implemented in informal Native Science programs. Through creating programs rooted in Native cultures and customs, educators were able to develop culturally relevant science lessons that connect science and the real world. Twenty-one individuals actively involved in directing Native programs in science and environmental science, and nine Indigenous science education experts participated in the study evaluating community developed science programs. The research data found that engaging community members in the development of Native Science programs was beneficial to student learning outcomes where community values and culture were the foundation of science instruction (Mack et al., 2012). Consequently, developing programs, such as supplemental science programs relevant to and distinct to underserved students communities are beneficial in science learning for students and in developing their identities in science.

Recognizing the importance of community, school, and family, for underserved student populations in science is essential. Barton and Yang (2000) discussed the need for science educators and schools to understand the relationship between culture, socioeconomics, and the science education of underserved students. The study focused on the struggles of a young father, Miguel, and his journey through education and in life. Miguel, in his early years, had a keen interest in science through brief experiences with the Boy Scouts of America®. Miguel was highly influenced by street culture, perceived school as a waste of time, and dropped out of high school in the 10th grade. Ultimately, after many dead end jobs and being homeless, Miguel earned his GED and acquired a job as a day laborer. According to Miguel, he never pursued science even though he had an interest in science because newspaper ads were never looking for scientists. This speaks to the prevalence of the culture of power, where rules reflect the culture of those who have power (Delpit, 1995). Barton and Yang (2000) used this story in their study to explain the existing disparities in science teaching, and the lack of support in pursuing science, postsecondary majors and careers in science for underserved, at-risk students.

Miguel's story was not uncommon and speaks to the issue of the culture of power. In addressing science education for underserved students seeking a strong science identity, Brickhouse (1994) argued that scientific ways of knowing are problematic for female and minority students who do not see their own worldviews reflected in school science. Consequently, Miguel's participation in school science and activities was discouraged from all sides. Miguel was vigorously advised to pursue a vocational track instead of a science educational track by his counselors and teachers (Barton & Yang, 2000). Additionally, family influences were devoid of encouragement to pursue science and attend school. The findings reflected that culture and power in the educational arena played a significant role in who stays on the sidelines and who flourishes in society (Barton & Yang, 2000).

According to Harackiewica, Rozek, Hulleman, and Hyde (2012), parents are a significant influence on how their children perceive and pursue advanced STEM courses, and seek postsecondary science majors and careers. There is a haphazard pipeline from high school to college that does not effectively guide students toward careers in STEM (Harackiewica et al., 2012). Harackiewica and colleagues (2012) administered an intervention over a 15-month period to high school 10th and 11th graders, and their parents where they received a series of promotional materials providing guidance for parents on how to discuss ways mathematics and science relates to them and the importance of mathematics, science, and STEM careers in their lives. Through self-reported surveys from parents and students, the study found that the educational level of parents influenced the course enrollment for their children. By conducting the interventions, an increase in parent-child conversations and the parental promotion about the value of STEM courses increased. Harackiewica and colleagues (2012) found that this intervention was a novel approach that adopted a family-level analysis, which suggests that the intervention worked in promoting parental involvement in their child's educational choices in STEM (Jeynes, 2007; Harackiewica et al., 2012). Therefore, schools should utilize novel approaches to provide parents with information about science, science courses offered, and the connections these courses have to science careers and professions for their children. Through these engagements among parents, students, and schools, underserved students gained a deeper interest in the sciences, which may encourage the pursuit of for careers in science.

A longitudinal study also explored the familial influences on high school students' movement in the science pipeline, and their science identity formation as a result of their participation and aspirations in science (Aschbacher et al., 2010; Gándara, 2001, 2006). The study sought to "understand what invites diverse young people to appreciate, desire to learn, and develop a sense of themselves as someone who does science; how they perceive and pursue their science interests and career options; and why so many young people initially interested in science eventually choose not to continue learning science or pursuing careers involving science" (Aschbacher et al, 2010, p. 565). An appraisal of students' attitudes on meaningful engagements, experiences, interactions, and practices in the science community was found to influence how students form identities that advances STEM skills, motivation, and interests in STEM careers. Who they are and who they wish to be, within communities of practice, were found to be highly influenced by schools and homes, and helped students become active participants and learners in science (Aschbacher et al., 2010; Lave & Wenger, 1991a; Wenger, 1998).

The life stories of students helped to explain how their schools, families, and extracurricular activities influenced the choices they made in academics, careers, and in life. The overall results of the study found that three distinct categories emerged, (a) Lost Potentials; (b) Low Achieving Persisters; and (c) High Achieving Persisters. The Lost Potentials category established that students with initial strong interest in science majors and careers no longer desired to pursue science by the 12th grade because of poor school experiences, lack of family support, and lack of compelling extracurricular science activities. Students in the Lost Potentials category perceived science careers as being too difficult and did not pursue science majors and careers. In the Low Achieving Persisters and High Achieving Persisters categories, most Persisters in both groups displayed a sense of purpose towards science majors and careers by the 12th grade, but the High Achieving Persisters were focused on specific science interest by 12th grade, such as enrolling in AP/Honors science classes, developing positive perceptions of school science, participating in compelling extracurricular science opportunities, and experiencing high family support. Subsequently, High Achieving Persisters acknowledged that postsecondary science would be hard, boring, and time consuming, but would not deter them from pursuing science majors and careers. The Low Achieving Persisters aspired to pursue science majors and careers, but demonstrated a disconnection between their participation and avoidance of hard science courses by 12th grade. In all three categories, family socioeconomic level, race/ethnicity, and gender influenced students' decisions in science engagement, majors, and career choices. Aschbacher and colleagues (2010) noted that students experiencing science opportunities and exposure are more apt to engage in doing science and see themselves as a science person, thus promoting interests in postsecondary majors and careers in the sciences.

Students engage in multiple social communities, such as family, school, and social groups, where a back and forth negotiation of their identities transpires within these social communities. Brickhouse, Lowery, and Schultz (2000) noted that biases are inherent in human activity, and biases exist in science and are a part of the social construct that potentially shapes interest and motivation in human endeavors. These biases can negatively impact underserved students' aspirations in science and hinder science identity development significantly (Brickhouse et al., 2000). For example, parents, especially minorities with limited education, were found to not see the relevance of science for their children and seldom related science to sustainable, paying jobs and/or careers that provide stability (Brickhouse et al., 2000). Because encouragement and support from family and community were often nonexistent, science interests and the pursuit of science courses and careers were limited for minority students. In order to promote student interests, motivation, and pursuit of science, Brickhouse and colleagues (2000) concluded that families and communities needed to be involved in the education of their youth in order for the relevance of science education and the opportunities it can provide for underserved students to emerge. In particular, families and communities needed to encourage and support their youth in conducting science activities, home projects, coursework, and science fairs that build confidence, skills, and relevant connections to real world science. Through family support, underserved students built a stronger connection to science and the benefits that emerged from learning science.

Supplemental Science

Outside-of-school supplemental programs in science are formal programs that support students in learning and development by giving those tools to build their young brains as they are motivated in science (Huppert, Lomask, & Lazarowitz, 2002). The main goal of supplemental science programs has been to support schools and to bridge gaps in order to improve learning and achievement for underserved students by increasing their understanding of instructional content, scientific reasoning, and problem-solving skills (Perna & Swail, 2001). Providing underserved students with unique science supplemental instruction has been a growing trend, but can be limited due to lack of access to university faculty and adequate funding. Consequently, to increase supplemental opportunities for the underserved, the Economic Opportunity Act of 1964 federally funded the first supplemental science and math academic instructional programs, such as Upward Bound, Sponsor a Scholar, and Career Beginnings, to help underserved students recognize the importance of math and science education, and postsecondary education and careers in science as viable options for their future (NCPPHE, 2010).

Green (2006) noted that in the 1960s, 1970s, and in the early 1980s, to address the needs of underserved students, supplemental academic instruction was developed to increase student learning and achievement in the sciences. For example, due to limited science resources in schools, underserved students were encouraged to take advantage of math and science learning-communities that supplemented their current knowledge in science, exposed them to new experiences in science, and built a positive relationship to science. These kinds of experiences for underserved students were significantly different from the regular experiences of students in schools (Green, 2006). For example, through the development of science learning communities that supplement the science curricula currently taught in schools, underserved students gained access to unique practices and activities, such as working with toxicologists, neuroscientists, epidemiologists and in other areas of scientific expertise in a university setting. Outside-of-school supplemental programs offer high school students academic instruction with a focus on college skills and careers. These programs have been primarily held in university research facilities during the summer and some extended through the entire school year. Cyclical learning takes place through matching high school students with mentors that guide students in conducting research, laboratory work, field experiences, and activities. Science supplemental programs have proven to be a positive influence on increasing learning and understanding science for students (Bell et al., 2003; Kimbrough, Dyckes, & Mlady, 1995).

Through an integration of outside-of school supplemental science programs by outreach organizations, and/or university faculty and graduate level students, underserved students gained science literacy while they developed and incorporated learning strategies to promote future goals and plans supporting identity formation (Blanc et al., 1983; Blanc & Martin, 1994; Brown, Reveles, & Kelly, 2005). Supplemental instruction offers the opportunity for underserved students to engage with science leaders whom they can emulate. Additionally, supplemental programs are not remedial programs where there’s a stigma frequently associated with membership: rather these programs set high expectations which offer activities that build skills and knowledge in science, as well as enhances students’ identities in science by actually doing scientific work. Through encouraging learning communities that diminish the remedial stigma often attached to academic assistance programs, a shifting focus to addressing high-risk topics rather than identifying students at-risk occurs (Arendale, 1993, 1994). A report by the Academic Competitiveness Council found that STEM supplemental programs create an educational pipeline in science for students who would not normally engage in the sciences in their schools (Gándara 2001, 2006; Winkleby, Ned, Ahn, Koehler, Fagliano, & Crump, 2014). In a supplemental program a student may learn science in a more diverse manner through activities that differ from what is being taught by the science teacher in school, thus offering the student diverse and culturally relevant supplemental support in the world of science. Subsequently, science supplemental instruction, in the appropriate setting can increase student learning and achievement, especially for underserved students where exposure has been limited (Green, 2006). Table 1 demonstrates a comparison between K-12 school science and supplemental science and the benefits of an immersive science experience where science learning and science identity formation takes place.

Table 1. K-12 Science Education v. Supplemental Science Programs

K-12 Science Education Under-resourced, Underserved Schools	**Supplemental Science Programs**
Setting - School based a. Classroom environment Duration - 9 months	Setting - University and/or organization based a. Scientific Community Duration - Summer – 6-8 weeks and Year round
Resources a. Laboratory 1. No laboratory or limited materials and equipment 2. Teachers - limited knowledge/skills b. Textbooks 1. Broad in scope - little support for the attainment of the key ideas 2. Not consistently aligned with standards/curriculum c. Field experiences 1. None or limited opportunities d. Student performance – based on 1. Grades 2. Assessments	Resources a. Laboratory 1. State of the Art Science Environment 2. Scientists advanced science knowledge/skills b. Projects 1. Advanced science knowledge 2. Advanced science skills c. Field experiences 1. Real science in the world e. Student performance - based on 1. Present research - Scientific Community - Schools - Science Fairs - Local and National conferences
Instruction a. Science curriculum 1. Varies by state, region, school district 2. Broad scope of standards b. Teacher guided 1. ‘One size fits all’ 2. Whole Class and small group 3. Less than 5 years teaching	Instruction a. Science curriculum 1. Discipline Specific 2. Individual research projects b. Scientists and Faculty guided 1. Individual one-on-one mentorship 2. Experts in fields of science 3. Extensive knowledge in science
Learning Community a. Large group b. Limited diversity c. Different functioning levels d. Science interest 1. See science as difficult 2. See science as boring	Learning Community a. Individual/Small group b. Shared interest in science c. Diverse group 1. Race, ethnicity, gender, religion varies 2. Different schools and grade levels 3. Different functioning levels
Science Learning a. Demonstrate basic knowledge and skills b. Basic understanding of science in the world	Science Learning a. Gained new knowledge, skills, and confidence b. New view of science as a science person

K-12 Inside-of-School Supplemental Science Programs

Supplemental instruction lead by scientist and university faculty has been an innovative way to capture the interest of students in K-12 education by sharing with them what scientists know and actually do in their work. In the US, there has been a societal shift in expectations for scientists to engage in K-12 science education in addition to their research efforts by engaging in STEM research and activities for a broader audience (NSF, 2014). In a study conducted by Komoroske, Hameed, Szoboszlai, Newson, and Williams (2015), scientists and teachers engage students in the inquiry-based learning (IBL) approach to support student discovery and knowledge acquisition in science. The study revealed students were more apt to embrace the activities and instruction provided in the classroom when teachers were better prepared and more knowledgeable about science topics as a result of the supplemental support by expert scientists (Komoroske et al, 2015). Subsequently, students were able to make connections between content, skills, postsecondary majors, and careers in science. Conducting IBL in K-12 education was found to be rewarding for scientists and beneficial for teachers and students. Scientists shared their expertise through hands-on inquiry-based instruction promoting problem-solving and a solution based approach to learning and research. However, study findings noted scientists faced significant time constraints, and had limited or no experience teaching IBL and/or collaborating with teachers. The primary expectation of universities has been for their faculty and scientists to focus on funded research which potentially impedes support for K-12 inside-of-school supplemental programs in the sciences. However, the overall consensus was that in order to increase sustainable student interests, knowledge, skills, and aspirations in science, scientists must engage in broader K-12 opportunities with teachers and students that incorporates adaptability, flexibility, and creativity in K-12 science education (Komoroske et al., 2015)

Moskal and Skokan (2011) compiled an overview of university K-12 supplemental programs provided for teachers and students in the areas of mathematics and science at the Colorado School of Mines (CSoM) to promote teacher efficacy and students' pursuit of careers in science and engineering. These supplemental programs were developed in order for trained graduate teaching fellows to provide follow-up science instruction and activities in elementary and middle schools, and to also enhance teachers' knowledge and understanding in mathematics and science. Research has found that Black and Hispanic students lag behind White students in standardized tests scores, and tend to lose interest in mathematics and science in grades sixth through eighth (Provasnik et al., 2012). This declining interest in science has been attributed to poor teaching, and limited resources and activities in mathematics and science in schools. As measured by pre- and post-assessments, the combined efforts of teacher workshops, ongoing teacher support, in-classroom instructional support, and a one-week summer camp for middle school students in mathematics and science, CSoM was found to help improve teacher quality and student performance in mathematics and science (Moskel & Skokan, 2011).

Fitzakerley, Michlin, Paton, and Dubinsky (2013) conducted an outcome evaluation of the Scientists-in-the-Classroom (SIC) approach to K-12 outreach through the University of Minnesota's Brain Awareness (UMBA) campaign. Scientists served as leaders in the K-12 educational community through generating interest in science. At the pre-collegiate level, classroom visits were conducted by scientists with a focus on their specific area of expertise. Students were able to explore science topics through unique experiences with scientists in their classrooms. UMBA provided the community, schools, teachers, and students with public lectures, brain fairs, and activities conducted by neuroscientists. For example, neuroscientists brought actual brain specimens into classrooms to expose students to the structures and functions of the brain. These classroom activities, conducted in collaboration with science teachers, encouraged best practices in science teaching and promoted student learning in science. Surveys completed by teachers and students to assess the impact of the classroom visits in 2010-11 and 2011-12 school years found that students learned from the supplemental hands-on activities, and teachers found the activities provided professional learning in specific science topics. Ultimately, both teachers and students gained new knowledge and skills they would not normally do in school.

Laursen, Liston, Thiry, and Graf (2007) evaluated student and teacher gains through their participation in the Science Squad (SS), a K-12 outreach program sponsored by the Biological Science Institute (BSI) at the University of Colorado at Boulder, and funded under a series of multi-year grants from the Howard Hughes Medical Institute. In this study, perspectives of SS presenters and teachers participating in the program were conducted through presenter observational data of teachers and teachers' self-reported data. Each BSI staff member conducted four presentations in their area of expertise to teachers which included lesson development and hands-on activities to implement in their classrooms with their students. Teacher observational and self-reported data of their perceived gains through the professional learning process were found to offer instructional benefits for teachers. Presenters were also found to gain benefits from their involvement in SS; however, they experienced some struggles with time, travel and logistical issues, as well as emotional costs due to limited support from academia in conducting K-12 outreach (Laursen et al, 2007). Teachers found that the activities encouraged students to ask and answer questions in science as a result of their participation in the activities. Overall, SS was found to be an effective supplemental science program that offered benefits for teachers and the students they teach. Through self-reporting their perceived gains, teachers were also able to become active participants and researchers in their classrooms.

K-12 Outside-of-School Supplemental Science Programs

There are thousands of excellent pre-collegiate, supplemental academic programs that connect research-based student-focused interventions with program evaluation designs (Rennie, 2014). Programs providing outside-of-school supplemental science instruction for underserved students have been essential to closing the science literacy gap between underserved students and students coming from more advanced backgrounds (Rennie, 2014). In the Handbook of Research on Science Education, Rennie (2014) noted that learning science in an outside-of-school program can be extremely impactful because of the personalized, contextualized, and cumulative characteristics of supplemental instruction that connects with students' unique backgrounds and experiences. There may be differences in what is learned in science outside-of-school compared to inside-of-school, but the learning processes are still very similar.

Rennie (2014) examined the impact science and natural history museum supplemental programs have on student learning in science, and noted that research designs must be sufficiently broad based in order to capture a range of impacts on underserved students. A diversity of learning objectives to encourage engagement and learning in students was developed. For example, when learning content in the context of a supplemental program, students need to find real world connections to their lives in order to promote learning outcomes that increase their knowledge base and stays with them once they leave the program. Overall, through their participation in a supplemental science program, students increased their interest and motivation to pursue science, as well as their acquisition of science knowledge and skills. Additionally, research findings also supported the premise that outside-of-school supplemental science programs help to increase knowledge and understanding, increase skills, and change attitudes and values, which were reflected in the enjoyment, inspiration, and creativity embodied by students through conducting the activities, participating in the social interactions, and progressing in science (Rennie, 2014). Furthermore, the need for advanced research through longitudinal studies that can potentially provide compelling data relating to the impact of supplemental science programs was noted by Rennie (2014). Empirical studies that span across years can provide relevant data supporting positive connections between outside-of-school supplemental science programs, and student learning and achievement in science.

The influences of supplemental science programs allow students to join in multiple social communities where they participate in scientific endeavors that facilitate identity negotiations aligned with the rules and values set by the learning community. Markowitz (2004) conducted a mixed methods study of the long-term impact and outcomes of the University of Rochester's Summer Science Academy (SSA), an outside-of-school supplemental science program for academically talented urban high school students. Through diverse students learning science through doing science in an enriching university environment, they were able to build a strong identity in science. Students, coming from schools and communities where they received limited exposure in science, initially had difficulty keeping up with the current skills, trends, and developments in science and technology, which is often a common occurrence for underserved students coming from under-resourced schools. However, through their exposure in the SSA program, students were able to build a positive relationship between science content knowledge and hands-on laboratory experiences that enhanced their performance in science (Markowitz, 2004). The overall findings of 96 follow-up surveys from SSA students enrolled from 1996 to 2002 reflected improved overall performance in science as result of their participation in the SSA. Furthermore, students exhibited motivation to enroll in more advanced science courses and to also seek postsecondary science majors and careers, which is the overall goal of supplemental science programs for the underserved.

The federal government was supportive of supplemental intervention for underserved students since the mid-1960s, because of significant achievement gaps among White and Black/minority students. Forty years of success has been linked to the federally funded K-12 supplemental academic program, Upward Bound (UB) Federal TRIO Program. UB provides supplemental academic support in the areas of mathematics and science for first generation, low-income high school students, in tenth through twelfth grades. Academic enrichment was provided throughout the year and six-weeks in the summer in order to prepare high school students to successfully enter college seeking postsecondary majors and careers in mathematics and science. In a report by Perna, Fenske, and Swail (2000), UB was found to be a rich outside-of-school academic resource to highlight future college majors and career paths for students. UB Math and Science offers 964 supplemental programs at U.S. universities, serving underserved students nationwide, but their enrollment is on the decline. In 2007 there were 71,247students actively enrolled in UB Education, 64,262 students enrolled in 2011, and 61,361 students enrolled in 2015 which reflects the decline in enrollment for underserved students in UB (Olsen, Seftor, Silva, Myers, DesRoches, & Young, 2007; U.S. Department of Education, 2007, 2011, 2015). However, a wealth of research has found that early intervention in the UB program promotes underserved students opportunities to gain knowledge and skills that positively correlates with an increase in college enrollment and completion, but schools must work with UB to actively bridge gaps that currently exist in the science pipeline (Olsen, et al., 2007; Perna et al., 2000; Perna & Swail, 2001). UB has a proven track record for enrolling their students in college; and unlike other university supplemental programs for high school students, UB‘s affiliation with students spans well beyond high school (Olsen et al., 2007). For example, UB students upon entering college can enroll in TRIO student support services, talent search, and training, which can be extremely beneficial to student success, but students must be more aware and vigilant in actively pursuing these opportunities (Olsen et al, 2008). UB and the TRIO support services can potentially ensure student success in college and upon graduation for underserved students, and schools must promote and work with supplemental programs to ensure higher levels of success for underserved students.

To further enhance student performance in science, an eight-week supplemental science apprenticeship program for high-ability secondary students to build an understanding of the world of science and scientific inquiry was the focus of a study conducted by Bell and colleagues (2003). Through semi-structured interviews, students described their apprenticeship experiences and science activities in the laboratories, as well as what knowledge they gained from inquiry skills and apprenticeship tasks. The findings demonstrated that the eight-week apprenticeship experience influenced the way a student viewed the world of science through gaining an understanding of theories and practice, which is an important component of understanding scientific work. Thus, the investigation supported the assumption that students will learn about science by doing science (Bell et al., 2003). For example, underserved students had limited exposure to science activities and mentorship by a science professional; however, through engaging in a collaborative internship with a mentor, underserved students learned real science from real scientists. Consequently, the internship experience was beneficial, but still more needs to be done to instill a science identity in students. Therefore, ongoing mentorship and engagement with students beyond the eight-week program to support interest, learning, and performance in science in students was found to be necessary (Kuh, Kinzie, Schuh, & Whitt, 2011).

A crisis exists in developing and sustaining underserved students' interests and learning in science and STEM. STEM education is disproportionately provided to poor and/or ethnic minority students, and has become increasingly difficult for students aspiring to gain access to skills, postsecondary majors, and careers in STEM (Blustein, Barnett, Mark, Depot, Lovering, Lee, Hu, Kim, Backus, Dillon-Lieberman, & DeBay, 2013). Numerous questions remain about the influence supplemental instruction in science has on underserved students' acquisition of knowledge and meaning in STEM. The examination of the resources, perspectives, and potential barriers urban high students may face when engaging in a STEM enrichment career development program was conducted by Blustein and colleagues (2013). Nine urban high school students, including six from a science focused public school and three from a comprehensive public school, participated in a STEM/Career Development summer program. Through semi-structured interviews conducted directly after their participation 12 to18 months later, students' beliefs about their academic work and their management of challenging work increased and students matured and progressed in high school through addressing future career plans. Additionally, students found science to be meaningful as a result of their experiences in the STEM/Career Development summer program, which supported student aspirations in STEM careers as well as for those students considering non-STEM careers. Students also acknowledged that a multitude of identities exist, and their racial, ethnic, familial, and cultural identities are an integral part of their educational lives. The students also recognized that the educational level and work experience of parents, socioeconomic status, and racial inequality can be attributed to the lack of resources in some schools (Blustein et al., 2013). Because of these societal and educational issues, the belief that STEM careers are not accessible, attainable, or gratifying can be perpetuated in students.

Colleges and universities developed outside-of-school programs to increase the number of students coming from low socioeconomic (low SES) backgrounds entering science and health-related careers. Winkleby and colleagues (2014) conducted a study of The Stanford Medical Youth Science Program (SMYSP), a five-week program that linked 24 low SES, underserved high school students with science resources. The 24 students were enrolled in various university science courses and labs in biology and chemistry in the SMYSP. For example, a cohort of ten students enrolled in Biology I class where the instructor provided hands on activities to promote student learning in a specific topic. As a result of their participation in SMYSP laboratory practicums, internships, seminars, and research projects, the student surveys revealed that they gained science-related experience, self-efficacy, and motivation in the fields of biology and chemistry. Furthermore, students participating in the SMYSP supplemental program advanced their knowledge in biology and chemistry through actually conducting scientific activities and experiments, thus increasing their confidence and abilities to do science.

A primary goal of university K-12 supplemental outreach programs has been to increase ethnic diversity on university campuses. Rodriguez, Jones, Pang, and Park (2004) described in their study how a federally funded outreach program from San Diego State University supported underserved tenth grade students from underrepresented backgrounds to advance in science and mathematics competency and identity formation. The six-week summer residential program was an academic enrichment program focusing on science instruction and laboratory hands-on experiences by providing two hour courses in biomedical sciences, statistics, literacy, and technology. Rodriguez and colleagues (2004) administered pre- and post-test of the Test of Integrative Process Skills (TIPS), and found that the program exemplified advanced practices that created a sense of competence and skill in science that helped students gain science literacy and grow personally through the diverse peer relationships they developed in the program. Through their experiences in the summer program, each student gained science skills, knowledge, and confidence as a science person with a stronger identity in science.

Summary

U.S. Science education has made various attempts to increase student learning for all students, but continues to fall short for underserved students. Many factors, such as segregation, poor teaching, lack of common standards, and limited resources have contributed to the gap in learning that exist for underserved students (Rennie, 2014). Thus, underserved students are disengaged in science as a result of these contributing factors in science education, which can diminish acquisition of identities in science (Varelas et al., 2013). Through conducting a review of the educational literature evaluating science identity formation in students, more in-depth information to help explain the relationship between science learning, exposure, and achievement and science identity formation was warranted. The research questions helped explore how students participating in science activities and practices in a supplemental science program increased their knowledge, abilities, and confidence in science, and fostered science identities in students.

Chapter 3

Methodology

This chapter provides a detailed description of the methodology that was utilized for this study and is organized into sections describing the plan and design for the research study. The purpose of this study was to examine the lived experiences a university supplemental environmental health sciences program had on science identity formation in underserved students. To answer the research questions, a phenomenological approach was selected for this study.

Rationale for the Qualitative Study

Qualitative research is a well-established mode of research in education, and draws on multiple methods, focuses on context, and is emergent and evolving (Lincoln & Guba, 1985). In the context of a university supplemental science program, common themes emerged as a result of students' experiences in the program. Denzin and Lincoln (2005) noted, "Qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them" (p. 3). In studying the influence science activities had on the development of science identity in students, a qualitative design was an approach appropriate for this study. There has been limited qualitative research focusing on young people's lived experiences in science. Additionally, qualitative research was warranted because most studies in this area consisted of quantitative research, case studies, and reflective interviews of adults in order to evaluate their career interests, interactions, and development of confidence in and identification with science (Seymour & Hewitt, 1997; Carlone, 2004; Furman & Calabrese Barton, 2006; Aschbacher et al., 2009). Becker (1986), and Denzin and Lincoln (2005) noted that, "qualitative research studies examine people doing things together in the places where these things are done"

(p. 27). The purpose of this study was to explore the influence lived experiences of underserved students participating in a university supplemental science program had on science identity formation, as supported by the science identity model developed by Carlone and Johnson (2007) and Gee's defined identity (1999). As noted in chapter one, science identity is defined as one who demonstrates a meaningful knowledge and understanding of science, motivates an understanding of the world scientifically, acquires skills in scientific practice, and sees oneself as a science person (Carlone & Johnson, 2007). These researchers and their perspectives on science identity made the explicit assumption that an individual's experiences in science influence one's science identity, which was related to the assumptions of this study (Wonch Hill & McQuillan, 2015; Carlone & Johnson, 2007; Gee, 1999). The current literature addressing science education primarily focuses on improving science teaching and supplemental instruction in order to meet the needs of a diverse population of students. However, additional qualitative research to evaluate the influence of supplemental science experiences on students provided rich data that is beneficial to evaluating underserved students' science identity formation. To add to the wealth of research, a phenomenological study of these students' lived experiences in a supplemental science program was conducted to answer the following questions: (1) *What are the students' perceptions of their lived experiences through their participation in a university supplemental environmental health science program?, (2) What influences do these science experiences have on students' understanding of science, science worldviews, and skills in scientific practice?, and (3) How do they see themselves as a science person through the emergence of the components of science identity?*

Rationale for Phenomenology

Phenomenology is research that is driven by fascination with the meanings that emerge from experiences. In seeking to expose, uncover, and reveal the perceptions of the experiences of human beings, the practice of phenomenology was essential to this study. Magrini (2012) noted that human beings are always in the world as '*beings-in-the-world'* and as '*beings-with-others'* (p. 1), and all activities are directed towards interpreting, understanding, and conversing about things that matter to them. In conducting phenomenological research through interviews, the researcher strived to uncover constructive relationships between one's personal self and action, between existence and performance, and between reflection and perception (Van Manen, 2007).

Eagleton (1996) noted that Husserl, the German philosopher and founder of phenomenology, pursued the development of new philosophical methods, which provided unconditional views to a civilization in a state of deterioration. A primary aim of phenomenology was to ultimately get back to the concrete by describing as accurately as possible the true phenomenon that exists (Moustakas, 1994). Welman and Kruger (1999) noted that, "Phenomenologists are concerned with understanding social and psychological phenomena from the perspectives of people involved" (p. 189). Furthermore, the researcher acknowledged predispositions, biases, and preconceptions, the *epoche*, which sets aside their beliefs and prejudgments that can potentially influence study findings (Moustakas, 1994).

In a community of practice (Lave & Wenger, 1991a), science seldom becomes a source of inspiration in underserved students' lives, and often stems from lack of connections between science experiences, students' culture, and the world they inhabit. A phenomenological perspective was effective for researching the influence a student's lived experiences had on science identity formation. To address these issues, a qualitative phenomenological research design, framed by science identity theory (Carlone & Johnson, 2007) was the most appropriate approach to discern science identity formation in students participating in a rigorous and immersive science program. Additionally, the social component of science identity theoretical design (Tajfel & Turner, 1986; Turner et al., 1987) was contingent on a phenomenological definition of identity, focusing mainly on group membership influenced by overall perceptions, evaluations, and emotions as a result of their lived experiences in the group (Tajfel, 2010, 1981; Turner, 1982). Therefore, the phenomenological research design was appropriate and described how science identity in students emerged from their lived experiences in a unique science-learning environment. The study focused on the themes that emerged from science experiences as underserved high school students conducted research, individual and group activities, laboratory work, and field experiences in the program. Program evaluation data, including weekly journal prompts, and exit- interviews helped support and inform the follow-up interviews conducted several months after the program concluded. The follow-up interview coding data included categories, sub-categories, and themes that emerged. This phenomenological research study explored, examined, and advanced a deeper understanding of how student peer interactions, engagement, and learning in science, promoted identities in science. Students must experience doing science by “having peers with whom to share science interests, who will enhance both girls’ and boys’, imagined future personal life as a scientist” (Stake & Nikens, 2005, p. 8). More importantly, the need for phenomenological research that connects the real world experiences of the student with the science world is essential to bridging the gap in science literacy, relevance, and beliefs that one can do science (Østergaard, Dahlin, & Hugo, 2008).

Participant Recruitment and Selection

Program Background Information

The university supplemental science program was hosted by Tulane University in New Orleans, Louisiana, and funded by the Gulf Region Health Outreach Program. The program was a competitive and highly selective science program focusing on impacting general science and environmental health science literacy, awareness, and science identity in underserved high school juniors and seniors from public, charter, magnet high schools in a four-parish region of Southeast Louisiana. The program has been in existence for four years, including summer 2016. And was conducted during the months of June and July, Monday through Friday, from 9:00 a.m.to 3:00 p.m. Selected high school students were matched with mentors and faculty advisors to support their completion of an individual research project in an area of environmental health science. Students also engaged in field experiences, rotations, and journal clubs. The director of the program served as the researcher in this study and was responsible for program design and leadership. The students received a $2000 scholarship award for their successful completion of the program. Participating in the study was not a requirement for admission to the supplemental science program.

The program has served a total of 35 participants over the course of the 4 years, including 19 females and 16 males. The demographic makeup of the participants includes African American (12), Asian (10), Caucasian (6), Arab/Middle Eastern (6), and Hispanic (1) students. Student tracking data received from 31 of the 35 students found that 22 students were currently enrolled in college and majoring in a science, engineering, or a health related field, three students were enrolled in college in non-science majors, and six students were in their senior year of high school and expressed plans to major in a science/engineering/health related field upon entering college.

Participating faculty were members of the environmental health science department with research interests in toxicology, epidemiology, environmental epidemiology, water quality, and industrial hygiene. For eight weeks in the summer, students participated in environmental health science rotations for the first two weeks of the program, engaged in weekly field experiences, and conducted an environmental health science research project over six weeks with faculty and graduate student mentors. Students developed a scientific poster presentation of their research project. During the program, the students developed science knowledge and skills in advanced laboratory techniques to enhance their current science knowledge and laboratory expertise. The students acquired one or more of the following laboratory skills and techniques based on the research projects they conducted:

- Microtome, Micro Pipetting and Restriction Enzymes,
- Chromatography and Polymerase Chain Reaction machines (PCR),
- Staining and Blotting Techniques,
- Cell Fractionation, DNA Extraction, RNA Extraction,
- Agarose Gel Electrophoresis, and Replica Plating

Program background data reflected that four of the nine students upon entry had knowledge of basic laboratory techniques, and five of the nine students had limited knowledge and skills in basic laboratory techniques because of insufficient opportunities to work in laboratories in their schools. Opportunities to participate in extracurricular activities, such as internships, supplemental programs, science clubs/organizations, and university courses, were not promoted in the low-performing schools. However, students who attended high-performing schools were offered opportunities to engage in science in- and outside-of-school frequently. Students who were enrolled in low-performing and under-resourced schools expressed in the background information from journals and exit interviews that many of their experiences in science were not positive and were inadequate due to limited resources. Consequently, their motivation to do science and their interest in science was hindered. None of the students participating in the program had prior experience in conducting research, and possessed limited or non-existent exposure and experience engaging in field work in their schools prior to joining the program. The majority of students expressed in their journals and exit interviews that they had general interest in science, but had not developed a strong connection to various facets of science. As a result of limited opportunities to perform science in their schools, six of the nine students express being disengaged in science. Through a review of the background information from journals and exit interviews, a need for further study of the influence supplemental science experiences had on increasing students' views, knowledge and skills, and their science identity formation several months after the program was warranted to explore.

A separate study of the university supplemental science program was sponsored by Tulane University across the eight weeks of the program and after the program concluded, which included student participation in weekly journal prompts, semi-structured exit interviews, and follow-up interviews. Potential study participants and their parents received an overview of the proposed study at the student/parent orientation held on the first day of the program. All nine students and their parents agreed for their child to participate in the study. Parent consent and student assent forms signed by the student and their parent(s) were required for students under 18 years old and student permission forms for those participants 18 years and older. The researcher acquired all consent/assent authorizations from parents and students, in order to conduct exit interviews, reflective journals, and follow-up interviews. An IRB approval was acquired from Tulane University (see Appendix J) and the University of New Orleans (see Appendix G) to conduct the follow-up interviews for this research study. The program evaluation data was useful program evaluation data that supported the development of the follow-up interviews that were conducted several months after the program concluded.

Student Recruitment

High school juniors and seniors were recruited from 40 public, charter, and magnet high schools in a four-parish region of southeast Louisiana. A pool of 85 applicants from Orleans, Plaquemines, Jefferson, and St. Bernard public, charter, magnet high schools in the four-parish region were reviewed by the admissions committee comprised of the director, faculty advisors, and mentors. The student admission criteria was as follows: juniors or seniors attending a public, charter, or magnet high school in the four-parish region of southeast Louisiana, an overall grade point average of 3.0 or above (reflected on high school official transcripts), an essay submission including a student biographical sketch, interest in science and research, educational goals after high school, and career aspirations for the future, and science teacher and counselor recommendations. An admissions rubric was utilized to facilitate selection of the finalists. Twenty-five finalists were selected by the admissions committee to participate in student interviews conducted by the faculty advisors and mentors. Each interviewer conducted three to five student interviews and ranked the interviewees based on the admissions rubric, which comprised of the application, essay, and interview evaluation rubric. Their number one choice was offered admission to the program. The remaining students were ranked on a waitlist. In the event the offer of admission was not accepted by the first choice applicant, admission was offered to the waitlist applicants respectively.

Participants

Nine students from Orleans and Jefferson Parish public, charter, and magnet high schools in the four-parish region of southeast Louisiana were enrolled in the supplemental science program for summer 2016. Five females and four males were accepted to the program. A Caucasian male (11^{th} grade) and an Asian female (12^{th} grade) both attended a high-performing Orleans Parish public charter high school, an Asian female (11^{th} grade), Arab female (11^{th} grade) , and Arab male (11^{th} grade) each attended a high-performing Jefferson Parish public high school, an Arab female (12^{th} grade) attended a mid-performing Jefferson Parish public high school, an African American male (12^{th} grade) attended a mid-performing Orleans Parish public charter high school, and an African American male (11^{th} grade) and African American male (11^{th} grade) each attended a low-performing Orleans Parish public charter high school.

Description of Participants

The nine student participants in this study are underserved high school students who participated in a university environmental health sciences program. The participants in the study came from predominantly underserved communities and under-resourced high schools, represented by three public charter high schools in Orleans Parish and three public high schools in Jefferson Parish. Six of the nine students came from low-socioeconomic backgrounds and attended urban under-resourced schools with 60% or more minority students. Five of the nine students would be the first generation to attend college. Three students attended high-performing high schools with an abundance of resources in science; therefore, their schools are not considered to be under-resourced. Although these high-performing high schools with abundant resources are not under-resourced; these schools serve a high percentage of underserved students.

All of the students had varied knowledge of biology and chemistry and laboratory skills. The nine participants met the following research criteria:

- Students attended a public/charter/magnet high school in Southeast Louisiana in 2015–16 academic school year
- Students were a junior or senior in the 2015–16 school year
- Students had a minimum 3.0 overall grade point average
- Students successfully completed biology and chemistry before entering the program
- Students came from an underserved community in Southeast Louisiana
- Students were admitted to the 2015–16 supplemental science program

Five students from Orleans Parish public charter high schools were accepted to the 2016 supplemental science program, a Caucasian male (11^{th} grade), an Asian female (12^{th} grade), an African American female (11^{th} grade), and two African American males (11^{th} & 12^{th} grade). The selected students came from four different Orleans Parish public charter high schools as follows: (a) a high-performing racially diverse (ranked #1 in Louisiana and #3 in STEM) (Louisiana Department of Education, 2017; U.S. News & World Report, 2017) public charter high school with an abundance of science resources and AP science courses offered, (b) a low-performing predominantly African American (ranked #28 in Louisiana and non-ranked in STEM) (Louisiana

Department of Education, 2017; U.S. News & World Report, 2017) military public charter high school with limited science resources and AP science courses offered, (c) a low-performing predominantly African American (unranked in Louisiana and in STEM) (Louisiana Department of Education, 2017) public charter high school with limited science resources and AP science courses offered, and (d) a mid-performing predominantly African American (ranked #25 in Louisiana and unranked in STEM) (Louisiana Department of Education, 2017; U.S. News & World Report, 2017) charter high school with limited science resources and AP science courses offered.

Two of the five students, a Caucasian male (11^{th} grade) and an Asian female (12^{th} grade), attended the high-performing public charter high school in Orleans Parish during the 2015-16 academic school year. Both students were enrolled in AP science courses, and were members of the National Honor Society (NHS) and science clubs/organizations at their schools in the 2015-16 school year. The Caucasian male returned to his high school for his senior year, and the Asian female successfully graduated and enrolled in a four-year university majoring in electrical and computer engineering in 2017.

Three of the five students, including an African American (AA) female (11^{th} grade) and two AA males (11^{th} & 12^{th} grades), attended three different public charter high schools in Orleans Parish. The AA female (11^{th} grade) was enrolled in a low-performing public charter military high school. She was a member of the Reserve Officer Training Corps (ROTC), but was not enrolled in AP courses or a member of NHS and/or clubs/organizations in science in the 2015–16 school year. The two AA males each attended a low-performing and a mid-performing public charter high school in Orleans Parish in the 2015–16 school year. They were not members of the NHS or science clubs/organizations, and were not enrolled in AP science courses in the 2015–16 school year. The AA male 12th grade student successfully graduated, and enrolled in a four-year university majoring in biology/premed in 2017.

Four students were accepted to the 2016 supplemental science program from Jefferson Parish public schools, an Arab male (11th grade), Asian female (11th grade), and two Arab females (11th & 12th grades). The students selected came from three Jefferson Parish public high schools as follows: (a) a high-performing predominantly Caucasian science and technology high school (ranked #2 in Louisiana and #201 in STEM) (Louisiana Department of Education, 2017; U.S. News & World Report, 2017) with an abundance of science resources and AP science courses offered, (b) a high-performing predominantly Caucasian high school (ranked #4 in Louisiana and non-ranked in STEM) (Louisiana Department of Education, 2017; U.S. News & World Report, 2017) with an abundance of AP science courses offered, but with limited science resources, and (c) a mid-performing predominantly Caucasian high school (non-ranked in Louisiana and in STEM) (Louisiana Department of Education, 2017; U.S. News & World Report, 2017) with limited science resources and AP science courses offered.

Two of the students, an Arab male (11th grade$^{)}$ and Asian female (11th grade$^{)}$ attended a high-performing high school. Although there were limited science resources in their high school, they were both enrolled in AP science courses, participated in science clubs/organizations, and were members of the NHS in the 2015-16 school year. There was an abundance of science resources for one of the Arab females (11th grade) enrolled in the high-performing science and technology high school. She was enrolled in AP science courses and a member of the NHS and science clubs/organizations in the 2015-16 school year. The remaining Arab female (12th grade) attended a mid-performing high school. She was enrolled in AP science courses, and was a member of the NHS and science clubs/organizations in the 2015-16 school year. She successfully graduated and enrolled in a 4-year university majoring in biology in 2017. See Table 2 below describing students' high school grade, population, and science resources.

Table 2: Description of Students, High Schools, and Science Resources

Student ID	Race/Gender	School Letter Grade	Student Population	Science Exposure/Resources
John	Caucasian Male	A-Selective High School 36% Economically disadvantaged	41.1% Caucasian 32.6 African American 16.4% Asian 9.9% Other	Experienced Teachers Lab exposure Lab resources Field Work/Research Projects
Ann	Asian Female	A-Selective High School 36% Economically disadvantaged	41.1% Caucasian 32.6 African American 16.4% Asian 9.9% Other	Experienced Teachers Lab exposure Lab resources Field Work/Research Projects
Mary	Arab Female	B-Nonselective High School 48% Economically disadvantaged	53.2% Caucasian 19.2% African American 13.2 Asian 11.6% Hispanic 2.8% Other	Experienced Teachers Lab exposure Some field work Lab resources
Susan	Asian Female	C-Nonselective High School 84% Economically disadvantaged	59.6% Caucasian 12.5% Hispanic 16.8% Asian 7.8% African American 3.3% Other	Experienced Teachers Some lab exposure Limited lab resources Limited field work
Thomas	Arab Male	C-Nonselective High School 84% Economically disadvantaged	59.6% Caucasian 12.5% Hispanic 16.8% Asian 7.8% African American 3.3% Other	Experienced Teachers Some lab exposure Limited lab resources Limited field work
Karen	Arab Female	C-Nonselective High School 72% Economically disadvantaged	41.3% Caucasian 35.3% African American 17.2% Hispanic 6.2% Other	Experienced/Novice Teachers Some lab work Limited lab resources Limited field work
Edward	African Am. Male	C-Nonselective High School 94% Economically disadvantaged	94.8% African American 5.2% Other	Experience/Novice Teachers Limited lab exposure Minimal lab resources Limited field work
Robert	African Am. Male	D-Nonselective High school 98% Economically disadvantaged	94.5% African American 5.5% Other	Novice Teachers Minimal lab exposure Minimal lab resources No field work
Rose	African Am. Female	D-Nonselective High school 98% Economically disadvantaged	94.8% African American 5.2% Other	Novice Teachers Minimal lab exposure Minimal lab resources No field work

Study Data Collection

Moustakas (1994) argued that data must be organized and analyzed in order to form structural meaning and essence within a phenomenological study. Drawing upon a phenomenological approach, data generation included face-to face semi-structured follow-up interviews conducted several months after the program ended. Semi-structured interviews make it possible for students to express their feelings and thoughts (Newton, 2010) as it relates to science and their experiences.

A separate study of the university supplemental science program was sponsored by Tulane University across the eight weeks of the program and after the program concluded, which included student participation in weekly journal prompts, semi-structured exit interviews, and follow-up interviews. Potential study participants and their parents received an overview of the proposed study at the student/parent orientation held on the first day of the program. All nine students and their parents agreed for their child to participate in the study. Parent consent and student assent forms signed by the student and their parent(s) were required for students under 18 years old and student permission forms for those participants 18 years and older. The researcher acquired all consent/assent authorizations from parents and students, in order to conduct exit interviews, reflective journals, and follow-up interviews. An IRB approval was acquired from Tulane University (see Appendix J) and the University of New Orleans (see Appendix G) to conduct the follow-up interviews for this research study. The program evaluation data was useful program evaluation data that supported the development of the follow-up interviews that were conducted several months after the program concluded.

Weekly Journals

The weekly journals (see Appendix A) were disseminated to the students via a Qualtrics® e-mail link once a week for weeks three through eight, resulting in six journals per student totaling 54 journals. Johnston (1994) stated that reflective journaling is the act of writing things down, and encourages individuals to process and reflect on experiences in different ways in addition to thinking about them or discussing them with others. The journal prompts found the students evolved over the course of the program and gained new skills, knowledge, and experiences they would not experience in their schools.

Observations

The program also conducted informal observations over the course of the eight weeks of the program and maintained researcher field notes. The observations were conducted by the director during morning meetings for 30 minutes, and at random intervals during rotations, field trips, and journal clubs. Field notes provided rich data documented observed daily interactions among the students, and the individual science experiences and activities they conducted. A number of researchers address field notes, their form, their meaning, their use and construction as a means to record what the researcher sees, hears, thinks, and feels through the course of the data collection process (Van Manen, 1988; Sanjek, 1990). Van Manen (1988) posits that the most common field notes are impersonal channels through which information about the field is conveyed to the reader, which supports the perceptions of the participants that emerge at specific points in time. However, Miles and Huberman (1984) stress that memos (field notes) must be dated so that the researcher can relate them to data found at various points and times.

Exit Interviews

Each student participated in a face-to-face semi-structured exit interview (see Appendix B) during the last week of the program. The exit interview included 31 open ended questions focusing on the student's strengths and weaknesses in science, group experiences (science and non-science related), laboratory/project work, and future plans and confidence in science. Photographs were also taken of the distinct locations where the students engaged in laboratory/research activities, group activities, and field experiences throughout the eight weeks of the program. These photographs facilitated student reflection and recall of past experiences.

Because the program timeline consisted of only the June/July months, the weekly journals, observation field notes, and semi-structured exit interviews from the program evaluation data was used as supporting information for the follow-up interviews and not a part of this research study.

Follow-up Interviews

The face-to-face semi-structured follow-up interview (see Appendix C) included 12 open-ended questions focusing on students' science knowledge, abilities, and lived experiences pre-program, during, and post-program, as well as the students' application of new science knowledge, skills, and experiences in their current educational environment. Furthermore, the interviews addressed challenges, peer interactions, and confidence in science. The follow-up interviews were 40 to 60 minutes in duration. Audio recording and handwritten notes were conducted during the interviews to support thorough interview data collection and analysis. Drever (1995) noted that a semi-structured interview is a very flexible conversational technique and is an appropriate approach when attempting to gain data on perceptions and influences as a result of experiences.

The follow-up interviews were conversational style and helped the participants feel at ease during the interview process.

Data Analysis

The logical process for coding data from a phenomenological approach is to identify, analyze, and categorize specific statements into clusters of meanings that represent the phenomenon of interests (Creswell, 2008; Creswell & Miller, 1997). The primary method of analysis in this study was a continuous coding process developed by Miles and Huberman (1994): open, axial, and selective coding.

Coding

Data analysis of the follow-up semi-structured interview transcripts included a coding process that involved a logical process of classifying transcript text at three levels. Analysis began with open coding, which consisted of the interview transcripts being examined line by line to outline individual concepts, categories, and subcategories (Miles & Huberman, 1994). Next was the analysis of axial coding, where connections between categories and subcategories were conducted, and also confirmed that the categories and subcategories accurately represented the experiences expressed in the interview transcripts (Miles & Huberman, 1994). Once the first two phases of coding was completed, the researcher looked for patterns and explanations in the codes (Miles & Huberman, 1994). Then, the integrative process of selective coding systematically looked for in-depth meanings that illustrated the defined themes. According to Reis and Judd (2000), the selective coding phase is a flexible semi-structured interview coding analysis suitable to generate information from which to draw emerging themes from categories. Additionally, in the selective coding analysis the researcher looked for data that was contradictory or undergirded one's own ideas of the study. Open, axial, and selective coding analysis of the semi-structured follow-up interview transcripts, provided rich, in-depth recorded data available for analysis (Strauss & Corbin, 1990), and established emergent themes relating to student development, scientific interest, and career aspirations as a result of one's lived experiences (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009). The students were assigned pseudonym student numbers ranging from one through nine to ensure confidentiality. The follow-up interview transcripts were uploaded to a password secure server to ensure confidentiality, and were retained for one year and made available for review.

Strengths and Limitations

The researcher is the director of the university supplemental science program which was the context for this study. The researcher had prolonged engagement with the students, which built a relationship and trust between the researcher and the students. Through building a relationship with the students, the interviews potentially provided more honest and in-depth data reflective of their lived experiences in the program. One issue considered was the researcher's role as an authority figure, where students may have felt compelled to reply to interview questions in a certain way as noted in detail in the researcher identity section of this chapter. To address this issue, students could stop the interview at any time, not reply to any or all interview questions, and/or discontinue their participation in the study.

Additionally, peer- debriefing, by a colleague outside of the supplemental science program, examined consistencies and inconsistencies of the data sources at the axial and selective coding phases and maintained and audit trail to delimit researcher biases. A follow-up meeting to review emerging categories, subcategories, and overarching themes found in the coding process was conducted with the researcher to address researcher bias, coding techniques, and accuracy of findings.

Additionally, a limitation in the study was the participant group was highly selective due to rigorous admissions criteria, including the restrictions of student recruitment to juniors and seniors attending only public, charter, and magnet high schools in the four-parish region of southeast Louisiana. Catholic, private, and parochial schools were excluded from recruitment. Furthermore, because of a funding shortfall only nine students were accepted to the program that year, which presented a small selective sample for this study. Students accepted to the program have a keen interest in science upon entry, and come from high-, mid-, and low-performing high schools. Consequently, generalizing study findings to underserved student populations in science was limited because of the selective sample, but based on program demographic data gathered over the past four years, over 58% of the students enrolled in the supplemental science program had come from under-resourced schools where science resources were limited. Still, generalizability of the study findings to other supplemental programs was helpful in informing program design, development, and curriculum for other supplemental science programs serving a diverse population of students from various schools and communities.

Additionally, the program was conducted only in the months of June and July, which is a restricted timeframe for data collection. Thus, conducting a follow-up semi-structured interview administered several months after the program concluded provided in-depth information relative to the students' application of new science knowledge, skills, and experiences in their current educational environment.

Research Quality

The follow-up interviews provided the researcher with the opportunity to gain the point of view of the students' experiences, actions, and interactions in the program. Barrett (2007) posits that, "Qualitative researchers seek to understand the phenomenal world through the study of events, actions, talks, and interactions" (p. 1). The interview open-ended questions provided opportunities for students' to reflect on their feelings, insights, and knowledge as they progressed over the course of the program, which can be potentially transferable to other times, settings, situations, and people in the program for upcoming years, as well as other existing supplemental programs. Lincoln and Denzin (2000) noted that, "qualitative research is a situated activity that locates the observer in the world" (p. 3), as well as enmesh the researcher in the study in order to acquire descriptive data. Thick description was described by Lincoln and Guba (1985) as a way of achieving a type of external validity. To further support research quality, the three phases of coding (Miles & Huberman, 1994) of the follow-up interviews provided categories, subcategories and emerging themes supporting the tenets of science identity formation in students, which is essential to success in science education, the pursuit of science, and science postsecondary majors, and careers.

Peer debriefing of emerging categories, and subcategories defined in the axial and selective coding phases were also conducted by a designated peer/colleague. Lincoln and Guba (1985) noted that, "Peer-debriefing is a process of exposing oneself (your research) to a disinterested peer for the purpose of exploring aspects of the inquiry that might otherwise remain only implicit within the inquirer's mind" (p. 308). A higher education colleague conducted a peer review and critique of overarching categories, subcategories, and themes that emerged from the three-step coding process, as well as helped identify, isolate, and confirm researcher biases.

Limited research on programmatic influences in supplemental programs has been conducted. Qualitative research to explore the positive links between increased motivation and interests in science as a result of student participation in unique and immersive supplemental programs was warranted. To further support research quality, this study provided in-depth qualitative data describing student's motivation, interest, and confidence to do science prior to entering the program, during the program, upon exiting the program, and several months after the program concluded. The follow-up interview provided rich data reflecting students' new knowledge and skills they gained in science, how they viewed themselves in the world of science, and their formation of science identities.

Researcher Identity

I have been in the educational profession for nearly 20 years, working as a special education classroom teacher and later as a director of special education. My path in education and research was not a traditional one. My undergraduate degree is in mass communications, and I worked in the public relations field for many years prior to entering education. Through my work in public relations, I saw that educational fundraising was required to fill a significant gap in science educational resources. This lack of resources impeded learning for students in underserved schools. As I traversed through my professional career, I ultimately sought a career in special education and was faced with teaching students with significant challenges in all academic and social areas. As an educator and novice researcher, it was very important to make learning relevant and relatable along with building the self-esteem of students. Through my work in the inclusion pilot project, I found a high level of disparities in science and math education for students in urban, underserved schools. Students from these schools faced a disadvantage in comparison to those schools with more advanced infrastructures in place, such as strong leadership, certified and committed faculty, curriculum specialists, and parental support and involvement.

Underserved students face numerous obstacles and struggles, such as poverty, lack of parental support, and lack of resources and quality teachers in schools, which significantly stifles how students perceive themselves, and their engagement and education in the world of science. The lack of resources in the sciences was just cracking the surface of these student's needs. The global economy is pushing science and math as flagship professions, but underserved students are disenfranchised from the competitive world market due to their disadvantages. As I progressed in my education and received a Master's degree in Educational Administration and principal certification, I began to view the world from not just the special education lens, but through the administrative lens. As I grow as a researcher, I am curious about how to close the gap between students from underserved schools and advanced schools in science.

It is paramount for research to explore the impact that unique, science-learning communities have on the ability for students to engage in and learn science in addition to building a positive science identity. As a result, when the opportunity was presented for me to lead a university environmental health science academy for high school students, I immediately accepted the challenge. This was a chance for me to create a research-based program from the ground up. I was able to envision and implement program design, activities, and field experiences to meet the needs of the students we aim to serve. My primary agenda was to reach out to urban, underserved students and encourage them to seek out an opportunity to learn science in a rigorous, multicultural research environment. What surprised me was the lack of interest from those students who need the science education the most. Through my interactions with underserved students in schools, they appeared to be disinterested, viewed themselves as less-than, and not worthy of seeking an exceptional opportunity such as the academy. They verbally expressed that they would not have a chance of being accepted to a program like the academy, and that supplemental science programs were strictly for students that attend the advanced studies schools. No matter how many speeches I made to groups of students, underserved students still erred on the side of caution when seeking science opportunities in- and outside-of-school.

It was disturbing to see the lack of support at the school level for enriching science activities and programs. Schools did not see the need to promote hands on science in their schools or as extracurricular activities. As a result, rigorous science experiences outside-of-school were definitely not a priority. This strongly impacts the priorities students place on science and math education. The underserved student's science identity was at a stalling point, and needed enriching lived experiences in science to send them in a positive science trajectory where they come to see themselves conducting science and being scientists. Underserved students did not believe they could engage in basic or advanced science activities. They do not have a significant belief, ability, and confidence in science learning and knowledge. That is when my keen interest in science identity formation in urban, underserved students came to the surface. As a researcher, I want to know how exposure to unique science activities, field experiences, research, and peer relations can positively impact science identity in underserved students. Through exposure to these unique opportunities in science learning, will underserved students gain new knowledge, interest in science, a belief they can do science and gain access to science majors and careers? As a researcher, this is at the core of what I hope to gain in my study.

Through my knowledge of educational fundraising, special educational issues, administration, and my work in the supplemental environmental health science academy, I strive to gain knowledge of how science identity emerges in underserved students exposed to unique learning experiences in science. Through my work in the supplemental science program, underserved students with limited science experiences are exposed to unique skills and practices in science and research. Students gain access to an exclusive club of researchers, science leaders, and educators who facilitate bridging the gaps in science that currently exists for underserved students. Also, science is a social learning experience, and the social component of the program is significant. When students enter into a science learning community where daily engagements with a diverse group of peers take place, students gain new worldviews not just of science to promote science identity, but also of the world in its entirety. As the director of the supplemental science program, I was enmeshed in the program and developed relationships with the participants who could pose researcher biases and predispositions. To diminish researcher biases I engaged in peer-debriefing with a colleague outside of the program during the data analysis phase of the study.

Chapter 4

Findings

Phenomenological research is driven by fascination with the meanings that emerge from experiences, and seeks to expose, uncover, and reveal the meanings that emerge from the lived experiences of human beings (Van Manen, 2016). The purpose of this study was to examine the lived experiences of underserved students participating in a university supplemental environmental health sciences program and the connection to science identity formation. This study sought to answer the following questions: (1) *What are the students' perceptions of their lived experiences through their participation in a university supplemental environmental health science program?, (2) What influences do these science experiences have on students' understanding of science, science worldviews, and skills in scientific practice?, and (3) How do they see themselves as a science person through the emergence of the components of science identity?*

The lived experiences of nine high school students that participated in a single supplemental science program are presented in this study. The study focused on participant science experiences as underserved high school students participating in research, individual and group activities, laboratory experiences, and field experiences in the supplemental science program. Program data, including weekly journal prompts and exit interviews, served as existing sources of data in addition to follow-up interviews conducted in this study several months after the program concluded. An analysis of the codes that emerged from the continuous coding process (Miles & Huberman, 1994) of the follow-up interview transcripts captured meaningful themes, reflecting their science identity formation as a result of their participation in the supplemental science program.

Each student participating in this study was categorized at one of three levels of science identity based on parental/family, school, and peer/community experiences in science upon entering the program. The three levels of science identity are as follows: minimal science identity, emerging science identity, and developing science identity. A student with minimal science identity is one who was enrolled in a low-performing under-resourced school, not enrolled in AP science courses or advanced science courses, and has experienced limited or no exposure to science in their upbringing, school, with their peers, and/or in their community. A student with an emerging science identity is one who was enrolled in a high-performing high school with limited science resources, or a mid-performing under-resourced high school, enrolled in advance science or AP science courses, and has experienced general exposure to science in their upbringing, school, with their peers, and/or in their community. A student with a developing science identity is one who was enrolled in a high-performing school with an abundance of resources, enrolled in AP/Honors science courses, and has experienced advanced exposure to science in their upbringing, school, with their peers, and/or in their community. This chapter includes a description of the experiences in the supplemental science program and the students' identities upon entering, during and upon exiting the program through the six themes that emerged from the interview data.

Study Findings

An analysis of follow-up interview transcripts provided the following six emerging themes to help explain science identity formation in the participants.

Theme 1: Opportunities to connect science to my personal interest

This theme ***opportunities to connect science to my personal interest*** encompasses the level of awareness students have of the various facets of science, how they view themselves in the world of science, and their pursuit of science activities to increase their depth of knowledge in the world. Singh, Granville, and Dika (2002) noted that motivation influences engagement in science and enhances interest in science for students. Fostering interest in the sciences has been shown to build identities in science for students well into adulthood (Carlone & Johnson, 2007). The majority of students expressed that because they were exposed to new areas of science they had never considered before, they were more motivated to engage in new science experiences, such as advanced laboratory work, research, and field experiences in the supplemental science program. Students were exposed to various disciplines in environmental health science through rotations in toxicology, epidemiology, industrial hygiene, disaster management, and environmental epidemiology. Students participated in demonstrations in the laboratories and also in the field through field experiences related to environmental health science issues relevant in their communities, such as Turtle Cove Environmental Research Station, LUMCON, and Port Fourchon/Harvey Gulf Marine, where students participated in coastal erosion Christmas tree projects, water quality experiments and bulkhead activities. Overall, students expressed their participation in rotations and field experiences expanded their awareness of various facets of science and how these various science disciplines can potentially fit in their lives. Visibly seeing real scientists conduct experiments in the lab and in the field, made science real and relevant for the students, thus motivating student to consider new areas of science interests at various levels. For some students their interest in new areas of science increased, they noted that they were not aware of how coastal erosion impacted their communities and were able to make relevant connections to why it's important to restore the Louisiana coastline.

Although the students from under-resourced schools entered the program with a vague and general interest in science, they were motivated to learn something new. Many of the students entered the program with a narrow view of what science entailed and how it applied to them, because of their lack of exposure to science. Robert was enrolled in a low-performing high school with limited science resources and had a general interest in science. He was not enrolled in AP or advanced science courses, and had limited opportunities in science. Robert didn't expect science to be so vast in nature, and he came to realize that the various areas of science are connected to the real world and to his community and stated:

> I was curious and willing to learn, and now I see how science is a part of everything and how I could possibly use it in the area of accounting, like working in an environmental company as an accountant or in some other area of business administration. Before this program my primary interest was finance and business, but now I am more interested in areas of environmental science and other options in science.

Robert acquired new interests and views of science and its impact on humans. He always wanted to pursue scientific opportunities, but was apprehensive or unsure as to what areas or fields in science he should consider. His exposure to rotations and field work in the program helped increase his awareness of the various facets of science. Robert was more aware of the various science disciplines in environmental health science and how these disciplines were relevant to him as an individual. Robert initially felt unprepared to conduct science, but through his experiences in the supplemental science rotations and field trips he became more aware of new areas of science he may want to explore, and he added:

> I am not certain if I would pursue science in college or as a career, but now I am more interested and motivated to explore how science and finance could potentially work in my future career in business.

As previously noted, Robert entering the program with limited exposure to science, but his interested and motivation to pursue science had increased. He wasn't certain of his path in science, but he had more direction and focus in science because of his increased awareness of the many facets of science he did not know before. Overall Robert expressed he had gained a new awareness of science and the infinite areas of science that he may pursue.

Similar to Robert, Rose also had a very narrow view of science and had limited exposure science in school. Her school was only a few years old and they had limited resources in science and she expressed:

> When I entered the program I didn't understand different parts of science, and always related science to solving math equations and conducting lab work. Going to the rotations and field trips helped me to understand science at a deeper level. I had never considered public health and how we treat our environment is so important.

Rose found her experiences in the rotations and in the field to be extremely helpful in building her awareness of environmental and public health issues. She was able to connect science to her life, and added:

> I always wanted to be a dermatologist, but really didn't know why. I guess it was mainly because I liked makeup and beauty products. I never knew the science behind being a

> dermatologist. But, now I am more aware of how to connect the many science disciplines I was exposed to in this program to dermatology.

Rose gained knowledge of other areas of science that she never considered before, like environmental health, public health, and how it impacts human beings. Overall, Rose had an interest in science, but didn't initially have the necessary tools to make informed decisions in her pursuit of science. Now Rose has a better understanding of science and how it relates to various disciplines and professions in science. Both Robert and Rose found new areas of science they were not interested in or exposed to before that they may want to pursue in the future, which is at the core of theme one.

Theme one also reflected how students with more exposure and advanced interest in science, expanded their interest and motivation to pursue new areas of science. Susan had a general science because of her science experiences in school. She attended a high-performing high school with limited science resources, and credits much of her knowledge in science to her high school science teachers. Susan noted:

> I attended a high-performing high school with good teachers, but we never had opportunities to do advance science and hands-on experiences like in this program. I still want to pursue a career as a medical doctor, but my exposure to genetics has made me want to explore how medicine and genetics could work together.

Susan discovered a new area of science she had never considered before that aligns with her plans to pursue a career as a physician. She wants to expand on her exploration of how genetics connects to her plans to pursue a medical degree.

Similar to Susan, Ann also developed new interests in science that connected to her current interests and pursuits in science. She had a developed science identity that was influenced by her exposure to advanced science in her school and upbringing. She had a definite plan for her future that influenced her perceptions of the space industry. She attended an advanced high school with extensive resources and opportunities to engage in science, and had worked in laboratories before the program, but she did not have experience in the field of environmental and public health, and stated:

> I have always wanted to pursue a career in the space industry, but had never considered before participating in the program, such issues as human health, water quality and environmental and public health for human beings going into space.

Ann gained a new interest in science she had never considered before. Through learning about new areas of science she was prompted to look for ways to integrate her new interest with her current interest in science. She valued her exposure to new areas of science, and the hands on experiences in the field, and her capacity to relate these many disciplines in science to her current interests. She initially felt prepared to pursue a science path in college, but gradually recognized she needed more than just theoretical knowledge to be successful in science. Ann found that the environmental health science rotations and the field experiences provided her with new areas in the sciences to possibly explore and pursue. Ann noted:

> I still want to pursue a postsecondary major in computer engineering for space, but now I have many new areas of interest that I am more motivated to consider for a minor in college, such as environmental or public health. I think the engineering side and the environmental side would work well together.

As noted previously, Ann entered the program with exposure to advanced science in her upbringing and in school. Her identity in science was strong, but she did increase her awareness in areas of science she was not cognizant of before. Ann's experiences in the program expanded her awareness of various subfields of science that may align with her interests and future pursuit of computer engineering. She has become more motivated to explore how these various science disciplines and subfields align with her current science interests.

The students were motivated to explore new areas of science and how it relates to their current interests and pursuits in science because of their exposure to new areas of science. Thomas attended a high-performing high school, with limited resources in science, and was not enrolled in AP or advanced science courses. He was interested in science, especially biology, and but expressed having limited interest in environmental health science and stated.

> The rotations and water testing, I had never been exposed to before. I wanted to pursue areas of biology that I was familiar with, but a biology project was unfortunately not offered in the supplemental program. I expected to work on a biology project with advanced science people, and that is what I would have been more comfortable doing.

Thomas was initially disappointed with the rotations, water quality project, and his limited exposure to biology based activities. He was mainly exposed to basic biology and chemistry in high school, and had never really considered water quality and stated:

> I do lots of things outdoors, and I have quite a bit of general knowledge of the environment, and this new interest I have in water quality goes well with things like hunting and fishing.

Thomas expressed he still had very little interested in the water quality experiments and research project overall in the program, but he surprisingly gained a great deal of knowledge about water quality despite my wanting to conduct a biology project. Despite Thomas's initial disappointment with his experiences in the program he became more interested in environmental science, and specifically water quality and its impact on human beings. He also discovered relevant connections to the outdoor hobbies that he enjoys in his life. This may be significant because Thomas was able to relate his hobbies to environmental health, human health, and potentially expand his interests in water quality to biology.

The first theme ***opportunities to connect science to my personal interest*** described how the experiences of students in the supplemental science program helped establish new interests in various facets of science and increased their motivation to pursue broader areas of science activities and opportunities. A key component found in the first theme was the fostering of identities in science for students as a result of their exposure to the many facets of science, thus promoting their interests and motivation to pursue science. As previously noted, there are thousands of excellent pre-collegiate, supplemental academic programs that connect research-based student-focused interventions with program evaluation designs. Programs providing outside-of-school supplemental science instruction for underserved students have been essential to closing the science literacy gap between underserved students and students coming from more advanced backgrounds (Rennie, 2014). The proliferation of supplemental science programs, prompted by the significant lack of science resources and opportunities in schools, has helped to supplement the current science curriculum being taught in schools, and has also helped to facilitate an increase in science interest and motivation to pursue science for students. Due to the limited science exposure and resources in their schools, Robert and Rose expressed they had a general interest in science, but because of their lack of experience engaging in science, they were not highly motivated to conduct science. Despite their limitations in science they had expanded their areas of interest in science which is represented in theme one. They gained awareness of new areas of science they connected to their lives. They expressed an appreciation for their exposure to new and vast areas of science they experienced in the program, and how these experiences expanded their general interest in science to higher levels.

Additionally, Susan and Thomas both had general knowledge of science, but their experiences were very different in the program. Susan developed interests in genetics and made relevant connections to her interest in pursuing a medical degree, where Thomas was initially disappointed in his science experiences in the program. He struggled with making relevant connections to environmental science, because of his lack of interest in environmental health science and seeking biology focused science experience. Overtime Thomas expressed he developed an interest in water quality that he was able to relate to his hobbies in life and to his interest in biology and human health. Whereas, Ann may have had a defined path in science that was deeply motivated by her upbringing and in school, she was open to learning new science. She was aware of many facets of science, but environmental health science was a new area of science she had not explored before. She gained a new interest in how human health and space travel connects and she wanted to conduct further exploration.

Overall, each student gained awareness of new areas of science, but the level of interest and motivation varied greatly from student to student. Robert, Rose, Susan and Ann valued their exposure to new and unique areas of science they never considered before, and how these new areas of science helped advance how they view science and themselves in science. Where Thomas didn't easily make connections between environmental health and other science professions and disciplines, such as biology but overtime he found environmental health science connections to biology. Theme one helped establish the importance of interest and motivation in learning science for students, and the influence interest and motivation has on their science identities.

Theme 2: Overcoming challenges in science knowledge and practice

The second theme ***overcoming challenges in science knowledge and practice*** encompasses the students' pursuit and attainment of advanced scientific knowledge to inform research and foster appropriate skills needed to successfully conduct procedures and techniques in science. The science identity model helps describe how students, through participating in enriching scientific activities, gain an understanding of the world scientifically through the acquisition of science knowledge and skills in scientific practice (Carlone & Johnson, 2007). The level of knowledge and skills provided in the supplemental science program were advanced in nature and normally not offered in schools. Each student entered the program at various levels of science identity and experiences in science.

Rose's school science instruction was not challenging and was based on textbook lessons with no hands-on lab work. Rose expressed:

> I had to work so hard to just get to the level some students in the program had when they came to this program. I had to learn to look beyond the surface and develop deep thinking and comprehension skills in science.

Rose felt she was at a disadvantage among the other students in the program, but she worked hard and gained new knowledge and met the challenge. She had to work harder than her more advanced peers and was stronger because of her pursuit of advanced science.

The core of theme two was the ability for students to attain advanced science knowledge and skills in order to conduct science, and Rose became an active learner in her acquisition of science. As an active learner, Rose participated in science activities and discussions, and took responsibility for her learning in science. She emerged as a problem solver with the ability to analyze and evaluate science content. Upon entering the program, Rose initially felt pressured to achieve up to the levels of her peers in the program, and aspired to reach their levels, but overtime she came to realize learning in science was individual in nature. She dedicated many hours in the lab, tirelessly worked with her mentor, and asked many questions to increase her learning in science. Rose emerged from the experience as an active learner with higher order thinking skills in science that she did not have before. She gained the ability to think more deeply and reflect on her science learning experiences and how these experiences have advanced her to a higher level in science. Rose worked hard to acquire all the knowledge and skills in science and also added:

> I learned how to think more logically and critically when I was conducting my research project studying the metal toxicity in E cells, and how these toxins found in the environment potentially kill the E cells. I worked hard to keep up and not feel silly or uncomfortable when I asked questions.

Rose felt more comfortable asking questions, and it was part of the learning process for her. She actively engaged and contributed in science. Active learning in science is essential to the acquisition of science knowledge and skills and through active participation in the science activities Rose was able to make gains. Her unrelenting endurance and commitment to science learning inspired her to be an active participant in her science learning and acquisition of science knowledge and skills. Rose took initiative and responsibility for her own learning in science. Karen attended a school with limited science resources and expressed a similar view and added:

> My school didn't have many things. Microscopes didn't work, lab equipment was old, and my teachers really didn't know much about computer programs and stats. I had never conducted statistical analysis before and this was new to me, but I always wanted to learn from someone more advanced than myself.

Karen stepped up to the challenge. She reviewed online videos and refreshed her math skills so she could understand the algebra behind the computer programs she was using. She shared her concerns in regards to her limited science knowledge and skills in statistics, and she was apprehensive about conducting a project using statistical analysis. Conducting statistical analysis required knowledge of mathematics, computer programs, and other background science content knowledge.

> In preparation for her project, I took initiative and studied various types of statistical analysis techniques and practiced using computer programs, such as SPSS and SAS.

Karen dedicated her time to learning the appropriate background knowledge and skills to support her advances in statistical analysis. Theme two encompasses not just science knowledge and skills, but the acquisition of supporting background knowledge that is essential to gaining a holistic view of science, and Karen accepted responsibility for her learning. She became a self-starter and was highly motivated to pursue further science education with little or no help from others. She reviewed online tutorials and manuals on statistical analysis independently. Overall, she became more scientific about the decisions she made and independently pursued areas of science and statistical analysis that she had not been exposed to before.

In contrast, John had experienced extensive science resources, exposure to science labs, and advanced instruction in his school and upbringing, and was confident in his science knowledge and skills. He was prepared to engage in the science learning experience in the program, but encountered procedures that were difficult for him to conduct and required guidance and support and noted:.

> I have gained new knowledge of toxicology and environmental health science, and now I can follow lab procedures, conduct safety protocols, and ask the appropriate questions when conducting experiments that I could not do before. I am more fluid in the lab.

Before John entered the program he could conduct lab experiments and procedures independently, but he had never conducted chromatography before or extracted DNA from blood sera. John had knowledge and skills in science to succeed in the program, but he faced issues when conducting the advanced procedures and working with laboratory machinery and technology. John was initially an independent learner, and didn't rely on others to help him in the lab, which hindered his progress at the start of his project. Due to the many issues he encountered in the lab, John sought help and support. John added value to this theme by expressing:

> I learned proper lab procedures with the support of others when working with biological organisms, such as collecting cells in the lab, and precipitating the vitamin D from the blood sera, and I know it is important.

Robert collaborated with his mentor and acquired technology skills that helped him discern what equipment or computer programs were needed and how to use them properly. He can explain scientific procedures and gained a firm understanding of technical and practical methods for science that he did not have before entering the program. Overall, he overcame many obstacles in the lab that he would have never considered.

John collaborated with others, and asked others for information, help, and support to address his issues in the laboratory. As an emerging collaborative learner, John came to realize science learning is an ongoing experience that cannot be conducted in isolation, but in collaboration with other science contributors. The key to success in science is to always be in a continuous learning pattern, where students build character through advancing their understanding of science content knowledge and skills, which is a key component of theme two. John also added:

> I worked harder than I ever had before to attain new knowledge and skills well beyond my current abilities in science. This was eye-opening for me and I am thankful for the help and support I received. I am truly humbled by the experience and I now know that learning science cannot be done in isolation.

John valued the collaborative learning skills he gained in the program. Theme two comprises students' attainment of science knowledge and the various skills they gain from the learning experience. Susan concurred with John that she had acquired new science knowledge and skills, and advanced to a higher level in science. Her research experience before the program was mainly studying science topics on her own, and she had never conducted a research project and expressed:

> I gained knowledge of genetics in the toxicology lab, and the environmental factors that impact public health. In my research project I also learned how to conduct PCR of DNA which increased my knowledge and interest in genetics.

Susan had a knowledge base in science that was primarily limited to biology and chemistry, and some experience in the laboratory. She learned how to review an experiment and work in a lab independently.

> I increased my knowledge well beyond most high school students and for that I am truly thankful. The lab work I conducted in genetics aligned with my interests to be a physician.

Susan expand her knowledge and skills well beyond the general science she had upon entering the program, but her acquisition of science knowledge and skills was not without it struggles for Susan. She provided examples highlighting the many struggles and challenges she faced in the laboratory and expressed:

> While conducting my research project I faced a series of obstacles and 'bumps in the road' that I didn't expect to happen. Lab procedures didn't work, cells dying, inconclusive results just to name a few struggles I faced. I related my struggles in the lab to the struggles my family experienced when we were moving to the US from India, when my family wasn't sure if we were going to be able to stay in this country.

The struggles Susan faced in the lab made her stronger, more knowledgeable in science, and better able to face obstacles head on, both in science and in life. She was able to take initiative when conducting science, because was knowledgeable in what she was doing in the lab. Susan was more resilient because of her struggles in the program. When facing difficulties she was able to quickly recover, and she gained toughness and flexibility. While it is common to think of conceptual skill and mathematical computation as important science skills, here we see evidence of an equally important, though perhaps less discussed, skill: persistence. She developed character as a result of her experiences in the program. She gained science content knowledge and skills, but she also learned to forge forward when she faced unforeseen challenges in the program. Susan's science identity developed further because of her challenges and struggles, which made her stronger in science.

Robert recalled specific challenges and struggles he faced in learning totally new science content knowledge and lab oratory skills in the supplemental science program, and noted:

> To work in a lab was a scary idea to me and I was anxious about it. I had no knowledge of toxicology and what it involved. I had never been exposed to these areas of science before, but after many trials and guidance from my mentor, I was able to gain a clear understanding of the basics of toxicology that I needed in order to conduct my project successfully. I learned how to us a micro-pipette, and conduct PCR and chromatography, which were procedures I had never done before.

The learning environment in the supplemental science program posed many challenges for Robert coming from an under-resourced school. He had a low science identity and a rather general interest in science. Having limited skills in science positioned Robert at a disadvantage in the lab when learning the basics of toxicology. He had to learn the fundamentals of science and how to think from the concrete to the abstract when conducting scientific research. Robert gained strength and fortitude in science because of his experiences in the supplemental science program. Robert was determined to acquire all the knowledge he needed to succeed, and added:

> It was so much to take in and learn at one time, but I settled down and read a lot of research, practiced lab techniques and started to figure out data-sets and the computer technology in science.

Robert had never used Excel, SAS, or SPSS before, but after numerous drills with the computer programs helped him learn how to develop data graphs and tables for his study and conduct evaluations of the data graphs, which were new computational and computer technology skills that he can take into any field of study. Robert also shared:

> I struggled with the data and technology and used my knowledge of finance and business to help me look beyond the practical applications to the more scientific reasons why we were working with the data.

Originally Robert was only concerned with acquiring laboratory skills, but he came to realize that science encompassed many other skills, such as data analysis skills. Robert also gained a deeper understanding of the important aspects of science and scientific practices. He acquired knowledge and skills, and can accurately demonstrate scientific practices to inform research, and added:

> In the beginning I had to learn basics like the scientific method and its application to science, research, and theory. This was a struggle for me because I had never studied theories before, but now I understand and think theoretically. I know the theory behind my research.

Robert can test the scientific method and connect theory with practice in scientific research. Now he can look beyond the practical applications in science and think more theoretically. He has gained a stronger science identity because of his increased science knowledge and ongoing commitment to science learning.

Edward aspired to gain new knowledge and skills in science, but he also had limited exposure to science opportunities in school. Robert express his high school did the best they could with what they had, but they did not adequately provide him with science knowledge and skills to work in a laboratory. And shared:

> I learn best in the lab through trial and error, and by doing things instead of just hearing about it or learning from a book. I had to put in a tremendous amount of time and effort to learn the science content and the lab skills needed to conduct my project. This was difficult, but with time I gained new skills and knowledge.

The supplemental science program was a challenging learning environment that presented many struggles for Edward coming from an under-resourced school. Similar to Robert, Edward had limited exposure to science and was not prepared to engage in the rigorous activities in the program. He was a hands-on learner that gained from the laboratory demonstrations. He also enjoyed the solitude of working in a laboratory and gained knowledge of cytokines, white blood cells, and diseases caused from smoking through conducting hands on lab work. Through his experiences in the lab, he learned the importance following specific lab procedures, maintaining thorough lab notes, and drawing conclusions from his work. Edward also added:

> I can develop and conduct experiments, ask the appropriate questions, and analyze the findings. Now my lab technique has become meticulous and I have become a science diagnostician troubleshooting problems that could potentially go wrong in the lab or with the research project.

Edward has become more analytical, conducts evaluations, and actively draws conclusions in science. Because of his experiences in the laboratory, Edward developed higher order thinking skills grounded in the fundamentals of science and background knowledge in toxicology.

Exploring science from the basic levels of research to the more abstract is what Edward gained in the supplemental science program and noted:

> I can now apply the fundamentals of science to many facets of science, and the field trips to Turtle Cove, New Orleans Mosquito, and Chevron expanded his knowledge of environmental and public health. I always assumed chemical plants were all bad for the environment, but when I learned of the effort chemical plants, like Chevron, put into keeping the environment safe, I gained new insights.

Edward's narrow view of science he had upon entering the program had expanded significantly to a more inclusive view of science. The interview data revealed that Edward found the field experiences to be hands-on learning opportunities that advanced his knowledge in science and in potential future career opportunities. He learned a wealth of knowledge about the spread of West Nile, Dengue Fever, and Zika by mosquitos to human beings because of his exposure to science in the program and said:

> I can look at science at the most fundamentally basic levels and up to the more advanced levels in science. I gained very much. Now I have more knowledge through a global lens and have a deeper understanding of the significant impact human beings have on the environment.

The science experiences and knowledge Edward gained in the field helped him expand to a global perspective in science. Through a global lens in science, Edward was able to discern where he may potentially fit in the world of science.

The second theme ***overcoming challenges in science knowledge and practice*** described students' current science experiences upon entering the program, and their acquisition of new science knowledge and skills, and the =gains they made because of their new knowledge and skills through their participation in the supplemental science program. Carlone and Johnson (2007) determined that without science knowledge and skills constantly increasing, science identities in students are stagnate and not growing (Carlone & Johnson, 2007), and theme two helps explain the influence new knowledge and skills acquired in a supplemental science program has on science identity formation in students. The rigorous curriculum offered in the supplemental science program presented a series of challenges for students.   Rose, Robert, and Edward encountered challenges in their acquisition of science knowledge and skills because of their limited knowledge and skills in science. Rose worked tirelessly in the lab to acquire the necessary knowledge and skills to conduct her research project. She became an active learner in science with problem solving, decision making, and comprehension skills. She gained higher order thinking skills that increased her ability to conduct research and laboratory techniques and procedures.   Robert acquired theoretical skills and can connect theory to practice in scientific research. He can test the scientific method, look beyond the practical applications in science, and think more theoretically. Susan became more resilient because of the many obstacles she encountered in the lab. She encountered numerous failed experiments, time management challenges, and inconclusive results, but gained new knowledge in genetics and it impact on human health. Karen gained in-depth statistical analysis skills and conducted an analysis of the resilience of pregnant women exposed to violence in their community.   John entered with advanced science knowledge, but encountered technical issues in the laboratory and he learned to collaborate with others in order to succeed in his scientific research and learning.

Theme 3: Mechanisms impacting confidence in science

The third theme ***mechanisms impacting confidence in science*** helps explain students' beliefs in their own knowledge and abilities to conduct scientific practices with proficiency. Theme three describes the level of confidence students gained as a result of their newly acquired science content knowledge and skills in environmental health science disciplines. Based on students' expertise in various science disciplines and techniques, students expressed that they gained confidence in their ability to engage in science activities and actively contribute to science research.

Carlone and Johnson (2007, 2014) note that science identity formation takes place across the learning landscape for an individual in science, and being proficient in science content and skills is essential to building a stronger science identity. Or, stated differently, knowing science content and having skills valued by scientists support the process of seeing oneself as a scientist.

Confidence sometimes related to how students compared themselves to their peers.

Robert had limited skills and knowledge in science upon entering the program, and minimal confidence in science, but as a result of his learning experiences in the program, he shared:

> I am more confident and able to give my fellow students more insight on what they are doing right or wrong and actually help make different experiments go smoothly.

As noted prior, building confidence in science was essential to forming a strong identity in science, and theme three encompasses the core idea that through building competence and confidence in science students also build stronger science identities. At other times, confidence came from what one could do independently. Robert gained independence in the laboratory through conducting scientific research and increased his confidence in conducting and contributing in science. He learned self-reliance and added value to the theme and stated:

> I can work in a lab by myself, develop lab plans, conduct experiments, and get results. That is something I could not do before this program.

The primary goal of the supplemental science program was to build confidence and identities in science for students through learning, conducting, and actively contributing to science. Robert entered the program with minimal confidence in science because of his limited exposure to science in school, but through his experiences in the program, Robert gained confidence in science. He can develop lab procedures, conduct experiments and work in the lab independently. Robert gained self-reliance in science. He believed in his abilities to independently execute scientific practices with proficiency and actively contribute to science, thus increasing his confidence in science. Robert understood the science behind the experiments and made connections to theory and practice.

Actively contributing to science is a core component of theme three and Robert came to rely on his theoretical knowledge, skills in scientific practice, and abilities in science. Similarly, Rose found the science work she conducted in the lab was new to her and her confidence came from doing things confident in science and said:

> In the beginning I struggled with science and really didn't know much about it because my school has nothing to offer in science, but now I am smart in science. I gained advanced knowledge of biology and biological experiments through conducting my project and can now conduct experiments in the lab I had never did before.

Although, Rose had no lab skills or confidence in science upon entering the program she gained advanced science knowledge and proficiency in the laboratory because of her work in the program. The work Rose did in the lab she felt was important to science and the community, and she valued the opportunity to work in a real lab with real scientists. She learned to ask the appropriate questions, troubleshoot issues, and make adjustments in the lab. Rose gained strategizing skills in science that increased her confidence to conduct and contribute in science. Rose also shared:

> Although I had limited lab skills when I came to this program, now I can do lab techniques, follow lab protocols, conduct experiments, and find results. I am competent in the lab and believe I can perform experiments with guidance. I also gained excellent organizational skills. I have grown in science in the program.

As a result of her engagement in lab experiments and research she gained organizational skills from the learning experience, which was a significant boost of confidence for Rose. Although Rose required guidance in the lab, she had the ability to organize lab plans and procedures and serve as a supportive lab technician because of her newly acquired organizational skills. Rose valued the organizational skills she gained in order to actively contribute to science. This newfound confidence perhaps emerged from her understanding that some *non-science* skills (like following directions precisely and seeking guidance as needed) are also components of the life of a scientist.

Edward also entered the program with minimal knowledge, skills, and confidence in science, and valued the contributions to science he made in the program, and gained confidence when his work was accepted and valued. Edward struggled with scientific writing and he stated:

> The academic community saw my work to have value and I was proud of that. I learned how to summarize my work into one document, and share my study with the academic community.

Although Edward had had minimal exposure in conduct scientific research, he gained confidence through conducting research in the program. He was able to share his findings in general language that everyone could understand. He gained scientific writing skills when developing his scientific poster, and became a meticulous science diagnostician troubleshooting problems that could potentially go wrong in the lab or with the research project. Edward became more confident in his capacity to independently conduct research and compile findings into a cohesive research presentation. Susan also gained confidence in science in the program and expressed:

> I came to realize the importance of the research I conducted and my contribution to environmental health science research, specifically in the area of genetics. I believe I am a thorough researcher and can efficiently conduct independent analysis and present scientific evidence in a professional and scientific manner.

Susan gained confidence in her ability as an in-depth researcher because of her learning experiences in the supplemental science program. Before she used to wait for others to take the lead, because she wasn’t sure of what was going on in the lab, but now Susan made gains as a science researcher. She could identify issues or problems, design a research project with guidance, collect data, and interpret and report findings. She was knowledgeable in the research process, and was confident science researcher and added:

> With the skills that I have developed in the lab over this summer, I am definitely more confident. I am able to be in the lab independently and I guess that was when I realized I could do this, and I was confident doing it.

Susan can think logically and analytically about complex problems in the laboratory and draw conclusions from experiments. She is focused and resilient in the laboratory and confident in her abilities to conduct laboratory techniques and procedures. Susan is confident in her capacity to work independently in the laboratory and she can lead others in conducting experiments (like designing and implementing procedures) in the laboratory. Susan was not confident in her abilities in the laboratory upon entering program due to her limited exposure in school, but now she can troubleshoot problems, ask appropriate questions, and efficiently complete experiments in the lab on her own. She is a confident laboratory technician who can identify salient techniques and procedures, and analyze results.

Like Susan, Mary valued her experience conducting her research project and gained confidence in her abilities as a scientific researcher. In school Mary never did lab work like a real scientist or had opportunities to explore different areas of science. In the program she got to work like an actual scientist would do and stated:

> Before the program, I never understood the science behind why we do what we do in the laboratory and in research. Now I understand the lab work and research I did throughout the eight weeks and what the results mean to the science community. I have the ability to do advanced lab work and research and I am more confident in my science knowledge and abilities as a science researcher.

Even though Mary had exposure to science in her science and technology high school, she had limited exposure to the work real scientist conduct in the laboratory and in research. Susan was going to the lab carrying out experiments and doing research on her own. Through her experiences in the supplemental science program, Mary became a competent science investigator, who could conduct scientific research independently. She is a confident laboratory technician and researcher, and has a deeper understanding of scientific research, procedures, and practices. She can work independently in the laboratory, and determine appropriate procedures, conduct experiments, and accurately present results. Mary gained confidence in science through actually conducting research independently with real scientists in their labs.

The third theme ***mechanisms impacting confidence in science*** addresses the students' beliefs in their own knowledge and abilities to conduct scientific practices with proficiency. The essence of this theme was the students' active progression from general to advanced science knowledge and their competent performance and contributions to the scientific community, thus increasing their confidence and identities in science. Each student faced obstacles in learning science due to the advanced nature of the science content being offered in the supplemental science program and Robert, Rose, and Edward entered with limited knowledge and confidence in science. As result of their learning experiences in the supplemental science program, Robert emerged a self-reliant and confident theoretical thinker, where Rose developed strategizing and organizational skills which promoted her science confidence. Whereas, Edward became more confident in his ability to conduct research and draw conclusions. Susan increased her confidence in science as an independent lab technician and researcher. Also, Mary gained confidence in science through conducting lab work and research like real scientists.

Theme 4: Understanding and applying science in the world

The fourth theme ***understanding and applying science in the world*** comprises how students apply their newly acquired science knowledge and skills. Theme four helps describe and explain how students use their newfound knowledge and in the process further develop their science identities. The science identity model encompasses science understanding and an individual's application of knowledge through three interconnected characteristics of *competence, performance, and recognition* (Carlone & Johnson, 2007). Ultimately, how students use their new knowledge and skills in their schools, communities, and in their lives is the core of theme four. Participants applied what they learned in a myriad of ways and in multiple settings.

Mary didn't know why she did experiments in school and its importance in science before she entered the program, but through gaining new knowledge and skills she shared:

> Now I can connect the science background knowledge to the experiment and how it relates to science in the real world. Now I can relate the experiments I do in my science classes to issues potentially taking place in my community.

Mary applied her knowledge of toxicology and lab techniques to her AP science classes in high school. She used her knowledge and understanding of the fundamentals of toxicology when conducting laboratory experiments, and how these experiments related to issues in her own community. Mary also added:

> In my AP biology class we tested water samples from a pond in a neighborhood near my high school, and we found E.coli and other bacteria in the water which can pose health risks for people and wildlife in the area. Now I can relate to how poor water quality could

impact my community because of my knowledge of water quality, health risks, and human health.

Mary also actively applied her knowledge of water quality when working in her high school science classes. She could relate the experiments to human health and community-based health issues that could potentially impact her and her community. Rather a than a knower of science content, Mary sees herself as something of a health activist that applies her knowledge in the community. She reflected articulately on this newfound identity:

> I now look at the bigger picture in science and the influence environmental health issues, such as water quality has on the community in which I live. In my independent research project in my science class, I developed guidelines to help prevent contamination of waterways with the hope to improve health conditions for me and community.

Mary became a health advocate in her community. She applied her knowledge of water quality to inform her community of potential health risks associated with contaminated water and the appropriate steps they could take to promote clean waterways. Science for her became not an interest and knowledge base, but a set of tools that could enact change.

Similarly, Susan also applied her knowledge of toxicology and lab skills in her science classes and in her community, and said:

> I used to analyze data in my labs at school, and never really knew what it meant to me or my community. When I conducted an experiment testing the surface of chicken for salmonella in my science lab at school, it was eye-opening for me. I came to realize that I can apply what I know in toxicology in science class and understand the effects of food borne bacteria and the health risks it poses to human beings.

Susan could connect science to health risks and human health. She used her analytical skills to make relevant connections to issues that impact human beings. She shared her knowledge with her peers in school and was able to actively explain her findings in general terms relatable to others and stated:

> I can connect findings from experiments to things occurring in the world. Science is more meaningful to me. Now I get it, because of my new knowledge in science I can apply what I know through doing science and understanding how science potentially improves human health locally and globally.

Now science is more applicable to Susan. She gained a deeper understanding of science because of her ability to think more analytically. She gained the ability to connect science practices to real issues and its importance in the world of science. A key component of theme four is how students actively connect their science knowledge to relevant science issues in the real world.

Similar to Susan, Karen applied her new knowledge and skills in school science and stated:

> I am a take charge researcher that shares my knowledge with my peers. I enjoy sharing my knowledge of science data driven research with other students. I have used my knowledge of statistical analysis in my science and mathematics classes and it's been extremely helpful to me when working with data points and equations.

Karen was an initiator that actively applied her new science knowledge in her science coursework. She used her knowledge of statistical analysis when working with data in her science classes and with her peers. Sharing and applying one's science knowledge and skills is essential to building a science identity (Carlone & Johnson, 2007) and Karen recognized the significance of applying her research knowledge and skills in school and in the community. She can relate her research study to issues she has witnessed in her community as it relates to violence and women and noted:

> I shared my knowledge of the impact violence has on pregnant women's resilience with my school social worker and family members. I feel obligated to share my research study with both men and women in my community with the hope my knowledge of the negative impact violence has on the resilience of pregnant women can instill potential change.

Karen emerged as a science and community advocate. She was willing to question her culture in order to make positive changes for women. The new knowledge Karen acquired behooved her to promote change in her community, despite the level of difficulty it may pose for her. Possession of scientific understanding, for her, came with an *obligation* to addressed social ills she observed in her community. Karen not only became a more able scientist, but an advocate promoting healthy living conditions for women.

Rose encountered a common struggle for students in under-resourced schools; where limited experiences to engage in school science thwarted her opportunity to actively apply her new knowledge and skills. She was at a disadvantage in comparison to those students who had opportunities to apply their science knowledge and skills in school, and could potentially lose her knowledge and skills because of limited opportunities to practice and apply these skills. Although sharing her new knowledge and skills in school science was unlikely because of her school's limited science offerings, she sought to relate what she learned in the program to real world issues and shared:

> My school has a health clinic where people from the community seek medical attention. I didn't know so many people do not have access to quality medical care until now. I would like to apply what I learned from my research by working with health professionals, students, teachers, counselors, and anyone in the community to talk about health disparities and how we could maybe make this situation better for people.

Rose was a socially responsible advocate, and applied her knowledge of health disparities through advocating for better health care for people in need. She utilized her new knowledge to address a significant problem that exists in her community, and to galvanize change in order to make a difference in the health community. And while her application was more aspirations for community organizing than explicit sharing of scientific knowledge, this suggests that perhaps she gained a certain amount of confidence through her laboratory work to engage with older community members in regards to public health. In this case, her work was less application of learned concepts than it was outreach activity possibly inspired by her developing science identity.

Similar to Rose, Robert also had limited opportunities to share and apply his knowledge in school science, but found ways to apply what he learned in science in his school and community. He had a multitude of ideas on how his school might offer more science opportunities that are relevant and relatable to real world issues and suggested:

> Science teachers should know the concepts they are teaching and find ways to connect these concepts to issues students can relate to, which would help me learn real science. We have moved into a new school building with extensive labs and equipment, but in my school we really haven't been in a lab, and our teachers rarely connect science to the real world, which is the way I learn best.

It is not uncommon for students to encounter obstacles when trying to apply their new science knowledge and skills in under-resourced schools with limited science resources. Robert found it hard to apply the new knowledge and skills he learned in the program in school science, but hoped to use the knowledge he gained in college and in his community. Robert was also at a disadvantage in comparison to his peers in more advanced schools, and risked losing his newly acquired advanced knowledge and skills due to limited opportunities to apply his science knowledge in his school science coursework. Although attempts to share his knowledge in school were scarce, he was compelled to share his knowledge of chronic alcohol consumption and its impact on human beings and said:

> I really have not been able to apply my skills much in school, but my research project is real to me. I studied the influence chronic alcohol consumption has on liver functions and the potential for diseases in rats.

Robert knew people who chronically consumed alcohol, and now he is aware of the potential health risks and wants to inform others of these risks. He shared his knowledge with his school community of the health risks associated with chronic consumption of alcohol and stated:

> I am a member of the science club and I helped plan our health week at school. I was able to apply my new knowledge in science and explained the health risks caused by chronic alcoholism to my peers.

Robert shared his research in general terms that high students could understand. He provided a handout listing the many health problems that are caused by chronic alcohol consumption and was able to answer their questions. Robert became a science spokesperson in his school. Without significant guidance from mentors in his high school, he applied his knowledge of toxicology and specifically in the area of health risks associated with chronic alcoholism in health week forums and information sessions. He was able to actively apply his knowledge to inform and advance his peers' knowledge in science.

The fourth theme ***understanding and applying science in the world*** described the application of new science knowledge and skills by students in their schools, communities, and in their lives overall. The core of theme four is the confident application of science knowledge and skills to benefit the world. Developing a deeper understanding of science through applying science in the world is essential to building competency in science, according to Carlone and Johnson (2007, 2014). Students have historically gone through science learning with a rote memory approach and rarely have the opportunity to internalize the science content and skills they are acquiring (Banilower et al., 2013). Although Rose and Robert were not able to apply their new science knowledge and skills directly in their schools, they revealed they were able to make relevant and relatable connections in science in their communities. Rose advocated for better healthcare opportunities for the poor as result of her exposure to health disparities in her research. Robert shared his research of the health risks associated with chronic alcohol use with his family, school, and community.

In contrast, Mary and Karen both were able to apply their knowledge in school science and in the community. They both emerged more socially responsible through advocating for improved health conditions as it relates water quality and women's rights. For those students with limited opportunities to apply their knowledge in school, there were concerns that they may lose their knowledge and skills because of limited use overtime, which may diminish their growth in science and science identities, but despite these limitations each student found various avenues to apply their knowledge and skills in the world of science.

Theme 5: Emerging relationships with peers and mentors in science

The fifth theme ***emerging relationships with peers and mentors in science*** describes the influence peer and mentor experiences had on their view of diversity, acquisition of science knowledge and skills, and social/collaborative learning. Theme five encompasses the influence peer and mentor relationships have on students' progression in science and their science identity formation.

Peer relationships. Working with peers sharing a common goal and interest was found to be beneficial to the social learning component of science. Learning is social in nature (Bandura, 1997) and peer relationships are an essential component of the social learning experience in science. Furthermore, social learning experiences in science promote the formation of strong science identities in students through the active learning process (Carlone & Johnson, 2007; Hurtado et al., 2009). Through providing peer engagement opportunities, students share their knowledge with others, thus promoting collaborative learning for students (Hurtado et al., 2009). Peer relationships came easily to Robert who was an outgoing student who sought new knowledge in science from others:

> I easily engaged with diverse peers because I am outgoing, which helped me overcompensate for my lack of confidence and knowledge in science. I listened to all of their views during the group discussions. I wanted to gain new knowledge from my peers in the program; they knew things I never was exposed to before.

Robert was a social learner and gained knowledge from his peers in the program. He teamed-up with others in order to get the most resources and skills in science and actively engaged in group discussions and activities. Robert collaborated with his peers to investigate important problems or to produce significant science projects. For example, in the industrial hygiene rotation, Robert teamed-up with two of his peers to conduct an experiment of the impact silica dust had on the lung function of factory workers, and he also engaged weekly journal club discussions addressing environmental health science research which encouraged collaboration with his peers. Robert had never engaged with a diverse group of peers, in- or outside- of- school in science and said:

> Being around eight different students was very different for me, because I attend a school where everyone is African American; I had never been exposed to so many different people before in one place. Discovering new information and views from diverse peers was impactful for me, and the friendships I developed expanded how I view science and engage with others in science and life.

Robert valued the opportunity to engage with peers coming from different races, ethnicities, cultures and religions who shared a common interest in the sciences, and valued the experience of meeting new people different from himself. He leveraged his social skills to enhance his science learning while interacting with his diverse peers in the program. He was enthusiastically exposed to attitudes, opinions, behaviors, and perspectives of other students.

Similar to Robert, Susan was open to engaging with diverse peers and noted:

> Basically interacting with others of different backgrounds and from different schools opened up awareness about other things out there that I might not see, but other people

> might see from a different perspective. I have never engaged with a diverse group of people who all like science and I gained a great deal from the learning experience.

Susan engaged in the social learning experience and enjoyed the common interest in science all the students shared. She actively participated in the social and collaborative learning experiences with her peers. For example, Susan and a peer in the program had to lead a journal club discussion focusing on an environmental health topic they were both found interesting. For example, the science program held weekly journal clubs that were hosted by teams of two students, and Susan shared:

> When leading a weekly journal club with a fellow scholar we worked really well together. I thought of things I had never considered relevant to environmental health, like violence in the community, teen pregnancy, and quality education. I shared my views about water quality, safe environments for children, and human health. Overall we worked together to design an interesting journal club for our peers to participate in.

Susan learned to collaborate with her peers in order to reach a common goal. Although Susan had limited experience working with diverse peers in science, she came to respect the viewpoints of others. Mary also embraced the social component of science and stated:

> My experiences with my peers in the program were very eye-opening. My high school has a homogeneous population of students, where everyone is basically the same (Caucasian), and I frequently felt like an outsider or different in my high school community due to my Arabic descent, but the unique nature of the program allowed for me to contribute to the group and speak freely since that rarely occurred in my school environment.

Mary’s engagement with diverse peers in the program was a beneficial social learning experience for her. She frequently felt like an outsider in her school and the social learning environment in the program gave her the opportunity to feel a part of the group. She felt accepted and respected in the group and embraced her new social experiences in learning science and shared:

> Engaging with students from different backgrounds was extremely helpful for me, and I learned a wealth of knowledge from my peers. Overall, I came to believe that everyone can contribute to science regardless of their race, ethnicity, or socioeconomic background.

Mary gained knowledge from her peers and was more open to the views and perspectives of others. Viewing peers from all backgrounds as active participants and contributors in science was impactful for Mary. In a world in which we see minority under-representation among science majors and science professionals, this change in viewpoint is significant. A diverse, and formative, experience like this could make significant impact on how participants’ subconscious views about *who belongs* in science.

But difference is not a simple thing. The students above described largely positive impacts of interactions with their diverse set of peers. On the other hand, Rose struggled engaging with diverse peers in the program, in part due to limited experiences with diverse peers in her previous life:

> I was not okay with engaging with students different from me. I’ve never been around a diverse group of students, and such smart students. I didn’t think I could keep up or have much I could share with them.

Rose originally assumed she was not smart enough to engage with others, and was apprehensive about interacting with her diverse peers in the program. She may have fell victim to the pervasive biases about who belongs in the world of science. She felt she would have very little to contribute to the group, and felt she was at disadvantage in science in comparison to her more advanced peers. Rose shared:

> In the beginning I felt like an outsider, but as I engaged with the students in the program I came to realize that I was just as smart as my peers. I have always struggled with 'being smart' and not being accepted by my peers in school because I was smart, but in the program I felt respected for 'being smart' and accepted by my peers.

Although Rose was initially reluctant to engage with her diverse peers in the supplemental science program, she came to see the benefits of social learning in science, and stated:

> I liked my new group of peers and participated in ongoing discussions about science and life with them. Being exposed to a diverse group of people showed me that opportunities are limitless, because there will always be options and other opinions to look to and consider.

Exposure to diversity is fundamental to social learning for students (Hurtado, 2001), and Rose found her peer interactions and relationships with diverse peers helped her gain a mutual respect for the views and perspectives of others in science and in general. With time Rose embraced her peers, was more apt to engage with others, and was an active contributor to the group.

Students coming from high-performing schools may have a less than favorable view of students coming from low-performing under-resourced schools with limited resources in science. Thomas also had limited exposure to a diverse group of peers and apprehensive about engaging with students from other schools and expressed:

> Prior to the program, I had a negative opinion of students coming from low schools, but now my opinion has changed and I can see everyone having a place in science. I learned a lot from my diverse peers in science. How I view my peers in science changed as a result of my experiences with my peers in the science program.

Thomas initially had a negative view of his peers in the program and assumed they were not as smart in science. Prior to entering the program he did not interact with others and worked in isolation, but overtime he came to realize he gained an abundance of knowledge from his peers in the program. He enjoyed the social aspect of science learning through his active engagement with his peers who shared a common interest in science.

Edward liked working alone and was not eager to engage with his peers in the program and stated:

> I am pretty quiet and keep to myself and I like the solitude of the laboratory where I section off and think through new information to learn. I didn't think I could learn much from the other students, because our projects were so different.

Robert was not initially open to developing friendships with people, but the field trips pushed him to be more open to developing relationships with his diverse peers in the program. Initially, Edward rarely engaged with his peers in the program, preferred the solitude of the laboratory, and struggled with the social component of the program. He did not actively engage with his peers in the lab; however he did engage with his peers in the field. He had never interacted with diverse peers in science and assumed the social learning experience with his peers would provide limited opportunities for him to learn science. Although Edward was hesitant to engage with his peers, he noted:

> In my school, everyone is African American and a small number of students are other races, so engaging with peers in the program was very different and difficult for me. But, it helped me gain a cultural sensitivity towards other people that I would have never acquired if I had not engaged with my peers in the program. We all shared a common interest in science and the social interactions in the program became a necessary part of the experience.

Edward came to accept peer interactions to be essential to learning science. He was eventually open to engaging with his diverse peers, but it was clear that he engaged with his peers primarily out of necessity, and described his experiences with his peers as being culturally enriching and helpful in the field. Social learning in science is a core component of theme five, and Edward gained cultural awareness and respect for the views and perspectives of others as a result of his social learning experiences with diverse peers.

The connections between social learning and peer interactions, helped foster learning, acceptance, tolerance, and openness when engaging with people coming from different backgrounds, and helped form science identities in students at various levels. Furthermore, mentor relationships will also be described to help explain the influence mentors had on science learning and science identities in students.

Mentor relationships. The student/mentor relationship was multi-faceted. Mentors demonstrated and guided students through the research process, and were instructors, collaborators, and leaders in their laboratories. The mentors guided the students in learning science knowledge and skills, and appropriate qualities in scientific research. Theme five encompassed the student's relationships with their mentors who influenced their science learning and identity in science. In collaboration with peer influences and relationships, the student/mentor experience was a core component of theme five. Susan's mentor experience was positive. Her mentor guided her through the research process, helped her develop as a researcher, and fostered her independence in the laboratory:

> I describe my mentor as someone I looked up to and would seek guidance to help decipher the research process. While conducting my project I gained a great deal of knowledge from my mentor. She was very knowledgeable in environmental health science and she modeled lab techniques and procedures.

Susan emerged from the program as a thorough researcher as a result of her mentor's advanced knowledge in environmental health science, laboratory techniques and procedures, and research skills. She learned how to develop protocols and procedures, and analyze data from her mentor. Susan gained theoretical and background knowledge in environmental health science, and emerged a stronger researcher. Even though Susan developed into a stronger researcher, this was not without its challenges:

> I could get help from my mentor when I needed it and she worked with me on every step in the experiments and throughout the research process and allowed me to conduct the procedures independently.

When facing challenges her mentor helped her develop patience and endurance, and to remain focused and to see the experiment through to the end. Susan can visualize, strategize, and conduct research effectively because of guidance from her mentor.

Similar to Susan, Mary also found her mentor's help to be invaluable, and added

> My mentor worked tirelessly to engage and energize me in the lab. He put so much time and energy into me, and because of that time and energy, I learned to be precise and accurate when conducting experiments, and how to conduct research.

Mary valued the amount of time and effort her mentor provided. Her mentor was an advanced university researcher that put a tremendous amount of effort into making her learning experience beneficial. These mentor experiences left a lasting impression for Mary and were a boost to her self-esteem. Mary also gained an important sense of her own independence and leadership abilities from her mentor and stated:

> I know now what it takes to be a leader and what I can contribute. He was my teacher and my lab partner, because I didn't work for him, but alongside him in the lab, which was a new and unique experience for me. I am a leader in the lab.

Mary's mentor guided her through the research process and allowed her to develop as a science researcher. Feeling treated as a co-equal researcher clearly left an impression on Mary. Having a mentor who treated her in this way appears to have given a confidence boost and a sense of responsibility for the overall success of her lab group. Overall, Mary's mentor modeled the appropriate behaviors as a leader in science and helped her develop leadership capacity.

Karen described her mentorship experience as one that pushed her to reach high standards:

> I wanted to work with someone more advanced in science that would push me to reach expectations that were hard for me to meet, and my mentor met my expectations.

Karen's mentor was very knowledgeable in environmental health science and helped her gain advanced knowledge in environmental epidemiology. However there were some obstacles faced by students in working with their mentors. Karen faced a challenge when she needed help using data analysis tools in her lab:

> She tried to explain information in the simplest forms for me, but she was not knowledgeable in the advanced computer programs needed to help me conduct my project. I frequently had to go to other mentors over and over again for help. This made it difficult for me to learn all that I needed to learn in a short period of time.

No student/mentor relationship is perfect, and Karen encountered issues where her mentor had limited knowledge in computer programs. She felt frustrated with the mentor experience and had to take initiative to learn the data analysis computer programs on her own, from other outside sources. This lack of mentor knowledge ended up resulting in a surprisingly positive opportunity for the mentor and the mentee to learn together:

> My mentor and I had to work together to learn the statistical analysis computer programs in order to conduct my project, which slowed me down, but I gained a great deal from the experience. I learned that no one learns in isolation, and through actually doing the

computer programs with my mentor, I learned how to work with my mentor and share in the learning experience.

Karen became a collaborative learner and self-starter who worked with her mentor in order to successfully conduct her research project. She was cognizant of the benefits she gained from working with her mentor and how they learned from each other.

Similar to Karen, John experienced a challenge with his mentor when working with advanced laboratory machinery:

> My mentor was knowledgeable in toxicology and laboratory procedures, but didn't know how to use the laboratory machinery, which was a big part of my project. I had to basically troubleshoot problems with lab machinery, read the manuals and ask other students in the program to help me figure it out. He was of little help when dealing with machinery and technology in the lab.

John was resourceful and rarely sought others for help, but he became more open to working with others as result of the challenges he faced with laboratory machinery. He encountered unforeseen issues with the lab machinery he had never considered before, and received limited support from his mentor. The lack of mentor support encouraged John to be more self-reliant, to actively take charge of his learning in science, and to collaborate with others to solve problems.

The fifth theme ***emerging relationships with peers and mentors in science*** described the influence peer and mentor experiences had on student's science learning, knowledge building, skill progression, and leadership in science. In peer relationships Robert and Susan were open to engaging and gaining knowledge from their peers in the program, and gained respect for the diverse views and perspectives of their peers. Where Rose was initially hesitant to engage with her peers in the program and felt like an outsider, but overtime through engagement with her peers in the lab she came to feel accepted and respected for the knowledge she could gain and contribute in science. Mary and Thomas both changed their views of their peers in the program. Mary felt like an outsider in her school because of her Arab descent, but through her experiences in the program she came to feel accepted and came to believe that everyone can contribute to science from all races, ethnicities, and religion. Additionally, Thomas had a less than positive view of his peers coming from low-performing schools, but through his social learning experiences with his diverse peers in the lab, he came to realize he could learn from his peers in the program.

As noted previously, the student/mentor relationship is a key component of theme five and is commonly used in supplemental science activities, which is found to be beneficial to learning experiences for students, especially when forming identities in science (Carlone & Johnson, 2007; Brown, 2004). The influence of mentor relationships for Mary and Susan were found to positive, and provided them with an abundance of opportunities to gain and share knowledge in science. Mentorship helps students to grow and learn in science, thus fostering stronger interest, motivation, and knowledge and skills in science emerging from the influence of the mentor experience (Carlone & Johnson, 2007), but Karen and John encountered less than ideal issues with their student/mentor relationships which stemmed from their mentors' limited knowledge in the project they were leading. Karen gained an advanced knowledge of environmental epidemiology and data analysis skills, however when working with data computer programs Karen had to work partially on her own and in collaboration with her mentor. Karen and her mentor learned from each other, basically training the training when working with computer programs. Where John gained knowledge of toxicology and advanced lab techniques from his mentor, but when working with laboratory machinery he had limited support. In order to successfully work the lab machinery, John had to seek the help of his peers in the program. Overall, a key component of theme five is peer and mentor relationships that students experience were found to be engaging collaborative learning experiences that benefit the student and the mentor which fosters a collaborative learning environment facilitating the formation of science identities in students.

Theme 6: Aspirations to be a science person and a member of the scientific community

Theme six ***aspirations to be a science person and a member of the scientific community*** encompass the students emerging interests. Rose had limited exposure to science due to attending a low-performing high school with limited resources and opportunities in science. She had a general interest in science upon entering the program had a low science identity. Rose wanted to pursue a career as a dermatologist but now her focus has changed, and shared:

> Participating in this program increased my interest in pursuing a degree in public health and working as a hospital administrator in the future.

Rose attained a better grasp of where she may fit in the world of science as result of her experiences in the supplemental program. The influence of the science program helped Rose make connections in science she had never considered before, and her plans for the future were changing and evolving. Although Rose advanced her science knowledge, lab skills, and developed organizational skills beneficial to working in a lab, she became more interested in the management side of science. For example, Rose determined her organizational skills would align well with managerial duties, similar to a hospital administrator. She also became more open to relationships with her diverse peers and felt accepted and respected by her peers. She is a science advocate working to decrease health disparities in her community. Prior, Rose had limited knowledge and skills in science, but has developed a stronger science identity that was influenced by the experiences she acquired in the supplemental science program. Ultimately Rose discovered she may not necessarily become a scientist or work in a discipline specific science field, but rather she envisions her path to be in management with a public health background.

The essence of theme six is the development of aspirations in science. Similar to Rose, Mary shared:

> I know I want to do science and I never considered other areas of science until I participated in this program. I always aspired to be a pharmacologist, but now I am considering toxicology as a possible career for the future. Now I know the options are endless in science because I am knowledgeable in the many disciplines in science.

Mary attended a science and technology high school where she had advanced exposure to science and aspired to pursue a career as a pharmacologist, but discovered other areas of science that she may be interested in pursuing. She valued the supplemental science experience and the knowledge she gained in the program, which helped her see new possibilities in science, such as toxicology Through conducting a water quality, toxicology research project, Mary found new avenues of science to explore that potentially connects to her initially interest and aspiration to be a pharmacologist.

Susan also discovered new possibilities in science and noted:

> I still want to pursue a career as a medical doctor, that really hasn't changed, but my exposure to genetics in the program has made me think about other opportunities. I want to explore how medicine and genetics could work together.

Susan has become more knowledgeable of the many possibilities in science and how she can explore these new areas as the result of her experiences in the program. Although Susan's still aspires to be a physician, she wants to explore how genetics potentially connects with her pursuit in medicine.

Edward has evolved as well in science and knows he wants to pursue a major in biology/premed and added:

> I feel I have the tools to make the right decisions for me in science. This experience really didn't change my mind about becoming a physician, but now I am equipped with the knowledge and skills I need to be a success in college and to make informed decisions.

Edward's aspirations did not change, but experiences in the program provided him with the necessary tools in science to support his pursuit to be a physician. He developed a deeper understanding of the basic fundamentals of science which reinforced his goal to pursue medicine and, noted:

> Before, I was a person that could do science, but now I am a part of the science community because I am more knowledgeable in science. I now can contribute in science.

Edward is now better equipped to pursue science. He initially could conduct science activities, but didn't connect how these activities aligned with his goal to pursue a medical degree. Now Edward is an active participant in science and can make the appropriate choices in his pursuit in science, as a result of his experiences in the program he has advanced his science identity.

Carlone and Johnson (2007) noted that finding ones niche in science is crucial to forming a strong science identity and Robert had a minimal science identity upon entering the program and noted:

> I still want to do accounting and I am not certain if science will be in my future, but I now have the knowledge and skills in science to help me make the right decisions. I could work as an accountant for an environmental friendly company or use my knowledge in the community where I live I now can serve as an ambassador of science in my school and community, and that keeps me actively involved in science.

Robert expanded his knowledge and skills in science which promoted his advancement in science identity. Even though he does not foresee a clearly defined path in science, he still aspires to pursue science through other endeavors, such as in school and in the community. Robert became more aware of how science potentially influences his involvement in the community, and the companies he may choose to work for in the future in business/accounting.

Becoming a member of the scientific community is the ultimate goal for John and noted:

> When I first entered the program I focused primarily on seeking a career in the space industry and that was my plan for the future. However, after conducting my research project, my plans in science have become more defined.

John entered the program with a high interest and exposure in science, and had a plan for future. However, his plans changed because of his experiences in the program and he added:

> I discovered a new area of science. I am certain I want to be a scientist and researcher working in my own lab in the future. I want to conduct research in neuroscience and focus on radiation in the environment. Much of this was sparked by my experiences in the program.

John has a defined path in science and has a plan for the future that has been influenced by upbringing, school, and supplemental experiences in the program. Through his experiences in the supplemental science program he discovered neuroscience. Initially John was interested in working in the space industry, but through working in the laboratory and conducting his research project he found a new are of science that changed his ultimate path to neuroscience. He aspires to become a neuroscientist with his own research lab in the future. Robert's science identity was influenced by his learning experiences in the program.

Theme six ***aspirations to be a science person and a member of the scientific community*** is the final theme and describe the development of science identities for students across their learning experience in the supplemental science program. Overall, theme six reflects the active the beliefs of students in their ability to engage and contribute to the scientific community, thus advancing their identities in science. Overall the students' experiences in the program presented many facets of science for them to consider, but not every student changed their future aspirations and goals. Their exposure to advanced knowledge, skills, and experiences in the supplemental science program influenced many of the students' pursuits in science. Some students discovered new areas of science they may wanted to pursue, such as John who initially aspired to work in the space industry, but now wants to pursue neuroscience, and Mary who wanted to pursuit pharmacology, but now sees toxicology as a better fit for her. Rose and Robert discovered science may not be a defined path for them; however they did discover how science could align with their aspirations to be a hospital administrator and accountant. Even though students were exposed to new areas of science, some students stood firm in their paths in science. Susan gained a new interest in genetics that she wanted to explore in connection with her planned pursuit to be a physician. Where some students found they now had a solid foundation in science that supports their aspirations in science. Edward found his new knowledge and skills in science helped reinforce his aspirations to be a physician and he now had the necessary skills and knowledge to make the right choices in science. Overall students gained new knowledge and skills in science that reinforced their current views and aspirations in science, expanded their areas of science, or changed their paths in science or other fields, thus promoting students' beliefs as a science person with a science identity.

Summary

The findings presented in Chapter four describe how nine participants developed science identities because of their experiences in a single supplemental science program. This chapter discussed the textural descriptions of what was experienced and discussed the structural descriptions of how it was experienced (Moustakas, 1994). Combined, they represent six emerging themes describing the essence of the experiences. A review of the data coding process and the six themes that emerged from the coding of the nine follow-up semi-structure interview transcripts was discussed An outline of the emergent themes provided detailed descriptions of themes and student quotes to help explain and support the findings of this study.

Chapter 5

Discussion

This chapter provides a discussion of findings and implications from this study of underserved high school students' formation of science identities as a result of their participation in a university supplemental science program. Findings from this study may inform program development of science instructional plans, activities, and field experiences offered in outside-of-school supplemental science programs in order to increase science knowledge, skills, and science identities in underserved students. This study examined students' perceptions of their participation in a supplemental science program, the new knowledge and skills they may had acquired, their application of new knowledge and skills through conducting science, and their potential to build a strong science identity.

The influence of the lived experiences of nine students participating in a university supplemental environmental health sciences program and their science identity formation was the foundation of this research study. In order to make sense of high school students learning in an eight-week university summer science program, Carlone and Johnson's (2007) science identity theory served as the theoretical frame for this study. The findings of this study point to the supplemental science program as contributing to science identity formation in underserved high school students. A three step coding process (Miles & Huberman, 1994) of open, axial, and selective coding revealed the influence supplemental science activities had on students' science perceptions, acquisition of science knowledge and skills, ability to do science, and confidence as a science person with a strong science identity.

This chapter will initially summarize the study, and follow with a discussion of the implications of the results as they relate to previous research. Additionally, a discussion of the study delimitations and limitations will be addressed. This chapter will also present future research considerations and conclusions.

Summary of Findings

The high school students who participated in this study and their perceptions of their lived experiences in a supplemental science program that influenced their science identity formation was examined through conducting face-to-face semi-structured follow-up interviews several months after the program concluded. The following research questions guided the study:

(4) *What are students' perceptions of their participation in a university supplemental environmental health science program?*

(5) *What influences do these science experiences have on students' understanding of science, science worldviews, and skills in scientific practice?, and*

(6) *How does program participation influence how they see themselves as a science person with a strong science identity?*

Analysis of interview transcripts through the open, axial, and selective coding process (Miles & Huberman, 1994) resulted in six emerging themes in Table 3 that defined the core of the students' science learning experiences and formation of their science identities.

Table 3: The Six Emerging Themes

Theme 1: Opportunities to connect science to my personal interest
Theme 2: Overcoming challenges in science knowledge and practice
Theme 3: Mechanisms impacting confidence in science
Theme 4: Understanding and applying science in the world
Theme 5: Emerging relationships with peers and mentors in science
Theme 6: Aspirations to be a science person and a member of the scientific community

To clarify, each student entered the program with an interest in science at some level. They were exposed to new and advanced laboratory skills and environmental health science knowledge in the program. The program schedule was highly structured, but also allowed time for students to engage with each other and build relationships through learning hands-on science. The first goal of the supplemental science program was for students' to increase their interest and motivation to do science, foster awareness of the many facets of science, advance their science knowledge and skills, and increase their confident in science, thus fostering stronger science identities in students. The second goal was for students to acquire new knowledge and skills in science in order to effectively conduct and contribute to science, which can promote a stronger science identity.

Integration of Findings to Existing Research

The findings of this study reflect components that contribute to build science identities in students. Students' participation in the supplemental activities provided opportunities in science learning in order to advance students' knowledge, skills, and confidence in science. Under the direction of faculty advisors, mentors, field trip hosts, and the program director, students were given the opportunity to engage in advanced science knowledge and skills in areas of science they may not have been exposed to in their schools. Collectively, the six emerging themes helped explain the awareness, knowledge and skills, and science identity formation of students, as a result of their participation in the supplemental science program, and the struggles and challenges students faced through learning science.

Pursuit of science knowledge and skills. To clarify, only students who had an interest in science participated in this study, but the level of interest varied from student to student. Chemers and colleagues (2011) recommended in capturing students' interest in science, one must provide enriching support and quality science instruction that can foster their pursuit of scientific knowledge and skills. Theme one ***opportunities to connect science to my personal interest*** revealed that the students in the study entered the supplemental science program at various levels of knowledge, abilities, and confidence in science, influenced by their science exposure and experiences in school and with their family and peers. Harackiewica, Rozek, Hulleman, and Hyde (2011) suggested that parents are a significant influence on how their children perceive and pursue science, thus posing significant disparities for some children. Ann was greatly influenced by her upbringing because her parents were both scientists, and she stated, "I always knew I would pursue science." Experiences in upbringing significantly influenced Ann's choices in science and promoted her pursuit of science opportunities. As noted previously, the environment in which a student is raised and the attitudes of their caregivers significantly influences a student's development in science (Mack et al., 2012). Although Robert and Rose experienced limited exposure to science in their upbringing which could have diminished their pursuit of science, they did give up their entire summer to actively pursue science through their participation in the supplemental science program, in order to advance their awareness, knowledge and skills in science. Robert and Rose, both experienced limited exposure to science in the home and in school, Rose revealed there were limited opportunities for her to pursue science in her school because of the lack of resources. Additionally, educational disparities in science emerge very early in schools for underserved students attending schools with limited resources and these limitations can negatively impact students' identity and the type of person they are seeking to be in science and in life (Carlone & Johnson, 2007, 2012; Gee, 1999, 2000, 2001). As a result of these disparities in schools and families, science learning communities, like the supplemental science program in this study have emerged to help fill the void that exists for students in science (Perna & Swail, 2001). For example, the environmental health science rotations in the supplemental science program exposed students to environmental health disciplines in the actual work environment, thus exposing students to scientific experiences promoting interests in science professions and careers. Gullatt and Jan (2003) concluded that supplemental programs have burgeoned since pre-collegiate programs emerged as an appropriate learning environment to expose students to various disciplines in science. The findings of this study indicate that students who profess an interest in science, despite having limited science background, can indeed be successful in a rigorous supplemental science program. There are stereotypes and skill gaps that must be addressed within the program, but these things are certainly within the reach of a well-designed program.

Carlone and colleagues (2008) concluded, "that engaging in scientific tasks has the potential to change students' ideas about science and how it is done, and thus to provide opportunities for students to develop identities as scientists" (p. 217). Theme two ***overcoming***

challenges in science knowledge and practice described the opportunities for students to engage in scientific practices promoting student learning in advanced areas of science. Furthermore, Carlone and Johnson (2007) noted engaging in scientific activities is essential to forming competence in scientific practices, as well as building a strong science identity for students. The interview data revealed that many of the students had limited experiences in the laboratory, and their exposure to science opportunities was primarily textbook based instruction and activities provided by novice science teachers, which limited their acquisition of vast areas of science. Science classes in under-resourced schools are more likely to have novice teachers with limited science content knowledge in the areas they teach, and lack appropriate certification in science (Wirt, Rooney, Choy, Provasnik, Sen, & Tobin, 2004). However, students coming from under-resourced schools were found to make advances when exposed to hands on experiences with their mentors in the supplemental science program. The mentors shared advanced science knowledge and skills they would not normally experience in their high schools. Through hands-on demonstrations and modeling, students gained new lab techniques from their mentors.

Aschbacher and colleagues (2010) concluded that an increasingly precious resource throughout the world is science knowledge and skills, and largely K-12 schools are falling short of preparing underserved students in science. The interview data revealed that science education has been primarily based on providing a basic knowledge of science grounded by textbook lessons and activities, but as the workforce moves to skilled and highly trained technology professionals in science, supplemental science activities and experiences are necessary (Hossain & Robinson, 2012). For example, many of the students in the program advanced their technology skills working with lab machinery and computer programs used to graph data and analyze research findings.

McClure, Guernsey, Clements, Bales, Nichols, Kendall-Taylor, and Levine (2017) noted that technology is a key element in science, and educational resources should ensure digital equity by providing technological programs through a digital infrastructure accessible to all students, as well as technology professionals to help students work with these programs. Furthermore, some students gained knowledge of statistical analysis and graphing skills through using computer programs, such as SPSS, SAS, and Excel to compile and analyze data. Hossain and Robinson (2012) concluded that professional practices in science are deeply grounded in technologically skilled workers, and underserved students need to be exposed to science knowledge and technology at a very early age in order to be competitive in the world marketplace in science. The interview data revealed that science teachers in their schools had limited or no knowledge of technology and data analysis programs, and viewed students' use of data analysis programs as counterproductive to understanding and learning science. Overall, data analysis skills are needed in the research process both in the lab and in the field when conducting and compiling research findings.

Contributing to science. The program design presented ample opportunities for students to become proficient in science knowledge, lab skills, and technology, thus potentially increasing students confidence in science. Many students entered the program with limited confidence in science and expressed they were unprepared to engage in advance science activities, but through conducting advance research projects, they each gained confidence to conduct science at many levels. Theme three ***mechanisms impacting confidence in science*** explained how students became proficient diagnosticians knowledgeable in science, thus forming stronger science identities across the learning landscape. Carlone and colleagues (2008) suggested students' perceptions of themselves as science learners actively engaging and doing science are critical aspects in building science confidence in students. The findings here show that finding a scientific community and being seen as a contributing member of that community was especially important for the students with the weakest science backgrounds. This has significant implications for the recruitment of students into selective science programs which often select for both interest and ability in science. Those who most need these all-encompassing science experience may be the least likely to get it f science ability is used as a screen at admission. In this case, science interest allowed for a diverse set of students, including those with weaker content backgrounds.

Furthermore, being an active learner in science perpetuates a feeling of belonging in science, which was exemplified within the parameters of the supplemental science program where students were actively conducting scientific practices. Furthermore, Bell and colleagues (2003) suggested that an eight-week science experience in a supplemental science program influences the way students view the world of science through gaining and understanding of theories and practice, which is an important component of science. Overall, the interview data found that through their participation in the supplemental science activities, students gained new knowledge in various environmental health science disciplines was able to conduct lab techniques and procedures, and draw conclusions from experiments.

Consistent with research, the inclusion of field experiences hosted in local communities also helped students gain new knowledge in science, and helped students make relevant and relatable connections to science which was the essence of theme four ***understanding and applying science in the world***. Anderson (2002) posits that in order for students to apply what they know in science in their lives, they must become inquisitive critical learners and thinkers; they must grasp concepts in science, mathematics, and technology, and acquire new ways of thinking through engaging in hands-on activities with real scientists and science professionals. Many of the involved students highlighted the significance of seeing real scientist conducting their work in the real work environment, and Ann noted, “It offered me a glimpse into what I would probably be doing if I worked as a computer engineer for NASA.” Ann had a high interest in pursuing careers in the space industry, and her engagement with space industry professionals during the NASA field trip helped her see what science professionals actually do in the workplace.

Students participating in the program rarely had the opportunity to engage in real science and field experiences and/or field work in their schools. Hands-on field experiences in science have proven to be a positive influence on increasing learning and understanding science for students (Bell et al., 2003; Kimbrough et al., 1995). In contrast, field experiences in the supplemental science program were considered an essential feature contributing to a productive science learning environment. All of the students expressed that the field experiences increased their science knowledge in areas they never were exposed to before, and exposed them to an abundance of science careers. Gullatt and Jan (2003) suggested in order to counter negative school influences encountered by underserved students in science, the addition of hands-on field experiences, similar to the experiences in the supplemental program in this study, are needed to improve student learning and achievement in science, as well as encourage the pursuit of postsecondary science majors and careers for students. For example, many of the students had a very narrow view of science and what science professionals actually do in the workplace, but through participating in field experiences, such as participating in coastal erosion projects with an environmental scientists at Turtle Cove Environmental Research Station, or conducting water testing with toxicologist at LUMCON, students were able to make connect science to actual professions they could pursue. The field experiences offered students a glimpse into what scientists and science professionals actually do in the workplace. Students were able to engage with science professionals, ask questions, engage in discussions, and explore many areas of science they may consider pursuing in the future. Many of the students were considering the pursuit of postsecondary majors and careers in science, although many of the students expressed they had limited science knowledge and skills, and experiences prior to entering the program. This mismatch presented both a challenge and an opportunity for the program to meet. There was already a good deal of interest in aspiration on the part of students, but some important understandings of the requirements and skill sets of the practicing scientist were often not fully in place.

Balancing and countering (sometimes implicit) negative views of science held by students was also a challenge presented to the program. Labov (2006) suggests that cultural and societal influences can diminish students' negative views of science and how they view themselves in the world of science. Numerous students viewed their research projects as relevant and relatable science issues currently impacting their communities, but not all students found there projects to be impactful to them personally. For example, Thomas was interested in science, but he did not initially find meaningful connections to the water quality project he was conducting. Researchers suggest (Rick, DeVane, Clegg, Peters, Songer, Goldman, & Hmelo-Silver, 2012; Wonch Hill & McQuillan, 2015) to make science meaningful, students must make relevant connections to how society and culture structure latent meanings in their lives and find meaning in their science experiences, thus promoting positive connections to vast areas of science. Additionally, Abrams and Hogg (1988) concur that science identity for students is shaped by the meanings that emerge from a learning environment guided by culturally relevant science. Although Thomas was not initially interested in his research project, he did express gaining new knowledge of water quality and its importance to human health.

Working with diverse peers. All of the students involved in the study engaged in community-based research, where they were active science learners with their peers and mentors in a collaborative learning environment. As described in theme five ***emerging relationships with peers and mentors in science,*** students actively conducted science with a diverse group of peers in a multi-cultural academic learning environment guided by their mentors. The National Research Council (2012) and Nasir and Hand (2006) noted that science instruction must carefully consider multiple levels of culture, power, and social structure through considering the participants local contexts. Banks, McGee, and Cherry (2001) concluded that science instructional content must be structured to norms, values, and concepts that are representative of diversity. In this study, many of the students attended high schools with homogeneous populations and had not engaged with peers of different races, ethnicities, and/or cultural backgrounds. As evident by the interview data of this study, despite some initial pre-conceptions, all of the students found that everyone had something to contribute to the group and that they learned to respect diverse views and perspectives. Mary stated, "Now I believe that everyone can contribute to science, no matter what race, ethnicity, or socioeconomic background of the individual." Many of the students' interview data revealed a positive change in their attitudes towards students from low-performing schools. Some of the students originally assumed that students from low-performing schools could not conduct science, but through their social learning experiences in the supplemental science program, many students came to believe that all students can participate in science. This is important because science learning is social in nature and is best conducted in a collaborative atmosphere where students are actively learning from each other (Duit, & Treagust, 1998).

Anderson (2002) noted that under-resourced schools frequently lack sufficient resources in science, subsequently causing a lack of student engagement and motivation to do science. Consequently, Thomas lacked motivation and was disengaged in the lab. He struggled with following directives and completing experiments. He was interested in science, but seemed to not put forth the effort to be successful in science. For example, Thomas didn't like the isolation of the lab, but when working with his peers he became engaged and motivated to complete experiments. Thomas said, "I really enjoy the social side of science learning by working in the lab with my peers and also going on all the field trips." Lave and Wenger (1991b), and Aschbacher and colleagues (2010) concur that learning science through meaningful student engagement, collaboration, and practice within social learning communities are beneficial to doing science. Thomas undeniably had struggles in the program, which could be attributed to the isolation he felt in the lab, the mismatch among him and his mentor, and his lack of interest in his research project, and this hindered his learning capacity in science. However, the social component of learning was particularly motivating for him. What was unclear was whether the lack of engagement in the lab potentially hindered his development of a stronger science identity. Perhaps a longer, sustained period of group activity may have prepared him for future independent lab work. This is a potentially area for future study.

Stake and Nikens (2005) suggested that students need to have peers with whom to share science interests. For example, when students participated in journal club activities, they engaged in group discussions which promoted sharing of science knowledge, views, and perspectives. Moreover, Labov (2006) and Hausmann, Schofield, and Woods (2007) recommend that African American and minority students benefit greatly from peer support, which tends to increase their sense of belonging while exposing them to relevant and relatable science experiences. Students with limited exposure to science bring a very different view of themselves and the world to the learning situation (Tajfel, 1982a), which can influence how they engage in challenging science activities. The findings revealed that through exposure to not only diverse experiences (rotations, research, field/community work), but also through engaging with peers very different from themselves, students learned from each other, and developed respect for diverse views, opinions, and perspectives. Given the drastic racial and socioeconomic disparities in science employment and the attainment of degrees in the sciences (Tyson, Lee, Borman, & Hanson, 2007) this may in fact be the most durable outcome of the program, and the most important finding of the study. This program's commitment to engaging students with a variety of social backgrounds created the type of peer diversity that can change unconscious bias. The opinions and perspectives of middle class families, those who are likely to one day sit on admissions and hiring committees, are incredibly important if we are to change the representation of the science workforce in the USA. If a program selects only low-income students of color, and prepares incredibly well, but they are denied opportunities because of the unconscious biases of others, then the program's ultimate objectives can never be met. Thus,

Forming science identities in students. Archer and colleagues (2010) also noted that existing literature and research suggest that students may be interested in science, but they do not see themselves actually conducting or contributing to science. Theme six ***aspirations to be a***

science person and a member of the scientific community describes the plans and actions individuals employ as active and contributing members of the scientific community, which fosters strong science identities. Overall, theme six reflects the active engagement and leadership capacity students developed because of their advancement in science knowledge and skills. The interview data found that some students were exposed to science at a very early age in their upbringing and throughout their experiences in school, where many of the students expressed they had limited exposure to advanced science. Olitsky and colleagues (2010) note that significant obstacles in learning, pursuing, and contributing to science exist for students from under-resourced schools, which prompts the need to include hands-on instruction guided by real scientists in real labs. This may be important to these students becoming active participants in the scientific community. For example, Rose and Edward initially didn't see themselves contributing to science and required extensive mentoring and support in order to gain the necessary knowledge and skills to propel them to the next level in science. Archer and colleagues (2009) also noted that as scientists and educators, we must encourage viable membership in the science community for underserved students, and consider how to bridge the gap between school science and real science for underserved students. Sustained commitment to ongoing science learning, active contributions to science, and future aspirations to be a science professional for students is the core components of theme six. But for some students in this study their path in science was not clearly defined which brings to question their level of science identity.

Belief in oneself is a determinant of success in science, and is a critical component to science identity formation for a student. Koballa and Crawley (1985) defines belief as "information that a person accepts to be true" (p. 223). Each student upon exiting the program had a belief in oneself as a science person at some level because “identities in science are fluid and dependent on environmental factors inherent to a learning community of practice” (Carlone et al., 2008, p.218). Interview data found that the students expressed they gained knowledge, skills, confidence and viewed themselves actively engaging in science; thus potentially promoting stronger identities in science.

As stated previously, Carlone and Johnson (2007) concluded that the perception of oneself as a science person through three interconnected characteristics of “competence, performance, and recognition” is a true indicator of science identity formation in a student. These characteristics are crucial to one’s overall development of a science identity and can be emergent over time (Carlone & Johnson, 2007, 2012). Overall, the themes are representative of the characteristics of science identity formation in students that participated in the program.

Through engaging in the supplemental science program, most of the students expanded their interest and motivation to pursue science, became proficient in advance science knowledge and skills, and believed they could actively contribute to the scientific community at various levels. The interview data revealed the each student progressed at various levels of the program, and the six emerging themes helped describe and explain their science learning experiences in the science program. Britner and Pajares (2006) suggested that once students are presented with new science knowledge and lab skills through doing hands-on science, they build confidence in science.

Implications for Supplemental Program Design and K-12 Science Education

This study raised several implications in addressing student learning, achievement and identities in science for supplemental science programs and K-12 science education or educators to consider. The findings suggest that when provided with learning opportunities in a supplemental science program, students gained new skills, knowledge, and confidence in science. Learning science in outside-of-school supplemental programs can vary due to the personalized, contextualized, and cumulative characteristics of supplemental instruction that connect with students' unique backgrounds and experiences (Rennie, 2014). In order to encourage a strong science identity rooted in student learning in science, supplemental science programs are recommended to offer activities and experiences students would not normally get in school science. This is an approach of *different science* rather than simply *more science.* The activities should be relevant to the students, relatable to real world needs, and represent diversity through conducting hands-on research and field work that is actually occurring in their own communities. Diversity is not only race and ethnicity, but the types of research and field work students engage in that is real to them. For example, students in the program conducted research using a plethora of hands-on techniques in research to explore real world issues they may experience in their own communities, such as Lake Pontchartrain water quality, health disparities in under-resourced communities, and the health risks associated with chronic alcohol consumption. Students need to find meaning in their science experiences and make relevant connections to how society and culture structure these latent meanings in their lives (Rick et al., 2012; Wonch Hill & McQuillan, 2015). Furthermore, the cultural and social components of science learning through supplemental learning experiences and programs can reveal new ways to view science education for underserved students, through a science identity lens, (Brickhouse & Potter, 2001; Carlone, 2003, 2004; Lemke, 2001; O'Neill & Polman, 2004). As previously noted, in comparison to K-12 schools where students are primarily limited to instruction guided by science textbooks, basic laboratory experiences, and a 'one size fits all' approach to science teaching or instruction, the social and cultural components of learning in supplemental instructional programs provides academic opportunities for students to engage in the scientific community with real scientists (Lynch, 2001; Green, 2006).

A strength of the program described here is requiring students to rotate through various learning settings during the summer. Having science rotations presents opportunities for students to learn about the different professions in science, as well as allow students to engage with real scientists and understand what they actually do in the laboratory. Furthermore, the field experiences offer additional exposure to relevant science topics and issues in the students' communities and can expose them to science professionals in the workplace. Granted, exposure to rotations and field experiences are productive activities to promote student learning in science, but often when students return to their under-resourced schools they have limited opportunities to apply their new knowledge. Supplemental programs should provide opportunities for students to continue their science research and activities outside of the summer months, which would support continuous learning; however, supplemental programs and schools would also have to develop and coordinate pathways for students to continuously conduct long-term research.

Through supplemental science programs and K-12 education collaborating in science, a student can progress well beyond the two months in a program and build a stronger science identity as a science person. Overall, K-12 education has fallen short of meeting the needs of underserved students in science and should embrace supplemental science programs that produce students with strong science identities rooted in science content knowledge, skills, and abilities to proficiently conduct science. This study found that students want to serve as science leaders in their schools and communities through sharing their new knowledge and skills with their peers. For example, students with advanced science knowledge and skills can mentor other students and serve as science ambassadors in their schools; however, due to under-resourced schools offering limited opportunities in science, mentoring others and advancement of science knowledge is inhibited. These solutions are relatively low-cost to the schools, and might be implemented as part of an afterschool club or service opportunity.

Moreover, there is some pre-existing evidence that science teachers frequently believe that "science is pure," and cultural influences in science pedagogy are not necessary (Brickhouse, 2001; Cobern, 1991). The evidence presented here suggests K-12 education should move to science pedagogy, diverse curricula designs, and culturally sensitive teaching and instruction, which is a similar science approach to what is often offered in supplemental science programs (Giere, 2010). Granted, current science standards encourage hands-on and inquiry-based science, but in practice there is limited implementation, and these limitations may suggest the need to include culturally relevant science in order to motivate underserved students to reach their full potential in the sciences, thus potentially fostering their development of a strong science identity (Schlitz et al, 2011). For example, the one-to-one mentor experience may be difficult to implement in K-12 science classrooms, but program activities, such as science rotations, lab work an field experiences could be incorporated into science instruction. Additionally, universities might share their program designs and collaborate with schools in science in order to promote learning for both teachers and students from real scientists. Furthermore, collaboration with K-12 schools would be beneficial to filling knowledge gaps for students, and could also facilitate a pathway to science postsecondary majors and careers for students. Although, supplemental science programs have attempted to fill the gaps in knowledge and skills in science for students, these supplemental science programs are limited in number and costly to conduct. Therefore, through developing collaboration between supplemental science programs and K-12 schools, cost may be minimized while still positively impacting students' advancement of their science identities at a very early age.

This study focused on high school students participating in a university supplemental science program and their formation of identities in science as a result of enriching science experiences. Supplemental support at the high school level promotes science interest, motivation, and pursuit in science, yet as evidence from Yager (2000) shows, K-12 education is losing the interest of students in science at a fast rate beginning in the earlier ages. Prior to high school, students in upper elementary and middle school become disengaged and lose interest in learning science gradually because of limited exposure to science in school (Yager, 2000). Science is often an afterthought in K-12 elementary and middle schools where the primary focus is on reading/language arts and mathematics. K-12 schools should develop science pedagogy that meets the intellectual and emotional needs of young adolescents (Yager, 2000). For example, the development of supplemental science programs that foster interest in science at the elementary and middle school and/or partnering with these schools at the lower levels can help promote, sustain, and increase science identity formation in students. Science identities in students develop significantly overtime, beginning in elementary and middle school, and the educational, cultural, and social experiences that students encounter have a level of influence on students' identities in science (Carlone, Scott, & Lowder, 2014).

Implications for Science Identity Theory

This study raised several implications in addressing the formation of science identities for students for the educational community to consider. The findings suggest that competence leads to confidence in science, and that students came to believe they could actively engage and contribute in the scientific community. Carlone and colleagues (2008) note that a science learning environment grounded in a cohesive learning community of practice fosters science identities in students. Through offering opportunities to engage in science through real world activities, such as field trips, rotations, and research with real scientists, students developed identities in science. Carlone and Johnson (2007) also concluded that science identity theory helps explain how students gain an understanding of the world scientifically through engaging in meaningful scientific activities. To promote science identity formation in students, the research suggests that science instruction should include unique learning experiences, such as hands-on lab work, community-based field work, and research.

Moreover, engaging with diverse peers in a science community of practice can also encourage science identities for students (Lave & Wenger, 1991b; Carlone & Johnson, 2007). The science identity model encompasses science knowledge, understanding, and skills in scientific practice that promotes the perception of oneself as a science person through three interconnected characteristics of *competence, performance, and recognition* (Carlone & Johnson, 2007, p. 1190). For example, when engaging in science activities with their peers, students gained knowledge and skills, but also learned to respect the views and perspectives of others. They can become more culturally aware and open to the views of peers different from themselves. Additionally, a person with a science identity is defined as (1) one who demonstrates meaningful knowledge and understanding of science content, (2) motivated to understand the world scientifically, (3) acquires skills in scientific practice, and (4) sees oneself as a science person (Carlone & Johnson, 2007; Gee, 1999). The evidence presented in this study suggests that these identity characteristics can be beneficial to students' overall learning and development of their interests, motivation, and pursuit of science, therefore science education should encompass opportunities for students to engage with their peers in science through collaborative learning grounded in identity work (Carlone & Johnson, 2007; Carlone et al., 2008).

Underserved students have been underrepresented in science fields. For example, African Americans and Hispanics represent less than 10% of degrees in STEM fields (National Science Foundation, 2014); thus providing activities that promote engagement and learning in science for underserved students is crucial to increasing their pursuit of science postsecondary majors and careers. K-12 education and universities must help steer students to science careers. These endeavors can help students gain an interest in science and enter science professions (Brickhouse et al., 2000). Although supplemental science programs help form identities for students, there is much more that needs to be done through the K-12 educational arena, such as the implementation of hands-on science, inquiry-based science, and culturally relevant and relatable science representative of the science standards, which is important to help students see themselves as a science person having a science identity.

Implications for Future Research

When looking at next steps in research, many possibilities emerged. K-12 science education, teacher quality, and supplemental science programs all have a significant role in the learning experiences of students. The proliferation of supplemental science programs has emerged in order to help bridge the gaps between K-12 education and higher education; thus further study of the influence supplemental science programs has on underserved students science learning is warranted. Studying the influence of multiple supplemental science programs could also potentially help explain how identities in science form in students coming from multiple supplemental science programs, as well as inform best practices in supplemental activities that could be potentially implemented in supplemental programs and science classrooms.

Additionally, conducting a study of the progression of the nine participants in this study through conducting yearly follow-up interviews could help determine the influence of the program experience on their postsecondary major and career choices. There is limited research looking at the long-term influence of supplemental science programs, and a longitudinal study of all the students who participated in the supplemental science program for the past five years could potentially capture rich qualitative data reflecting their progression of these students well into adulthood. This study could help reveal what experiences in their science learning influenced their decisions in education and in their lives. Finally, exploring collaborations among K-12 education and supplemental programs could help provide best practices in teaching for both the K-12 science classroom and supplemental science.

Student/mentor relationships are also an important component of the supplemental science learning experience for students. Through conducting research of the student/mentor experience, training the trainer, could provide best practices in mentorship for universities, bridge programs, and supplemental programs to consider.

Delimitations of the Study

Participation in the study was delimited to high school students who (a) attended a public/ charter/magnet high school; (b) were a junior or senior in the 2015-16 school year; (c) had a minimum 3.0 overall grade point average; (d) completed biology and chemistry with a 'C' or better before entering the program; (e) came from an underserved community in Southeast Louisiana; (f) expressed an interest in science in their essay and interview; and (g) were admitted to the 2015-16 supplemental science program. This delimitation allowed for only high school students with an interest in science to participate in the study.

In addition, the study was restricted to only high school students that participated in the 2016 university supplemental science program. Also, because of the restricted timeframe of the supplemental science program to June and July, follow-up interviews were conducted after the program ended from April to May, 2017. Lastly, high schools were delimited to public, charter and magnet high schools in the four parish region of Orleans, Plaquemines, St. Bernard, and Jefferson.

Limitations

There were a number of limitations to this study that require review. The sample was a small participant group of nine racially diverse high school students coming from high-, mid-, and low-performing high schools. Generalizability of the study findings to a more broad population of students was limited, as a result of the rigorous admissions criteria and restricted recruitment to juniors and seniors in southeast Louisiana public, charter, magnet schools, thus, resulting in a small and highly selective participant sample. For future studies, increasing the number of students participating in the study, as well as lowering the requirements to a 2.0 GPA, could help with generalizability to other student populations. Furthermore, opening the applicant base to additional parishes in Louisiana in addition to Orleans, Plaquemines, St. Bernard, and Jefferson could help to evaluate science learning in students and evaluate their formation of science identities in more schools across a broader region.

As previously stated, the program was conducted only in the months of June and July, which was a restricted timeframe for data collection. Therefore, the inclusion of the final semi-structured interview administered several months after the program ended provided data findings in the students' current educational environment and community. To advance this study further, conducting follow-up interviews once a year for the next five years could potentially provide in-depth information on science identity formation well into adulthood for the nine student participants. To further study the influence of supplemental science programs on high school students, a comparative analysis of selected university supplemental science programs on their influence on high school students' science knowledge, skills, and science identities warrants exploration.

It is important to include that the researcher is the director of the university supplemental science program in a discussion of the limitations of this study. In conducting phenomenological research through interviews, the researcher strived to uncover constructive relationships between one's personal self and action, between existence and performance, and between reflection and perception (Van Manen, 2007). Bracketing 'epoche' was utilized to help reduce researcher bias. Subsequently, peer debriefing at the axial and selective coding phases was conducted with a colleague outside of the program to limit researcher bias.

Overall, this study can hopefully prompt further discussion in the science educational community. There has been a wealth of research providing a variety of science educational practices and techniques to advance science knowledge, skills and confidence in underserved students. The introduction of inquiry-based science instruction, culturally relevant science, social science learning, and hands-on science to promote science identity in supplemental science programs has caused a major shift in science education. As a result of this major shift in science education, it is critical that supplemental science programs and K-12 science education work collaboratively to explore the next steps that are essential to building a science literate community of high school students with identities in science.

Closing Statement

The diversity of the participant group and the plethora of opportunities the students engaged in during the supplemental science program was a significant part of this study. The six themes that emerged from this study helped answer the research questions, thus showing the perceptions of each student participating in the supplemental program, and the advanced knowledge and skills they each acquired, which resulted in each student seeing themselves as a science person with a stronger science identity. This study has illustrated that science identity represents a compilation of experiences which creates a pathway for students to navigate from one experience to the next in science (Carlone & Johnson, 2007; Settlage et al., 2009). Hopefully, the science educational community can reproduce the supplemental science program design wherever advanced science instruction is needed to increase science learning in underserved students. Ultimately, the goal of this study was to capture the core of their experiences as each student formed their individual science identity in the supplemental science program.

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APPENDIX A

WEEKLY REFLECTIVE JOURNAL ENTRIES – PROGRAM EVALUATION

We are asking you to write a journal entry focused on answering and reflecting on the journal prompts indicated below. We ask that you complete each entry, write your response on the web link provided, note the Week Number and submit by the due date. Your responses should be detailed, and a minimum of 250 words or approximately one half page, maximum 1000 words. We will download your journals at the close of business on the due date. Thank you for your participation!

Week 3: A) Now that you are a few days into the science program and have participated in science activities, what topics/experiences have you found (a) most interesting and (b) least interesting? How will you apply your current knowledge in your science research project?

B) What expectations do you have for the science research experience?

Week 4: Describe two things you learned in science since you have been in the program and how you plan to incorporate this science knowledge in the program field experiences, and in your science coursework in school?

Week 5: Do you foresee any barriers or constraints to conducting your science research project and activities? These potential barriers or constraints do not have to be science related.

Week 6: Explain your science research project and its value/relevance to you and your community.

Week 7: Write a letter to future program participants providing some advice on how to gain science knowledge and skills, as well as how to engage with peers in science.

Week 8: 1) Go back and read your Week 1 Journal entry and review photographs of program locations where you participated in activities both individually and in a group. Please describe, evaluate, and reflect on what you have gained (a) educationally, (b) socially, (c) emotionally, and (d) personally as a result of your experiences over the course of the 8 weeks of the summer science program.

APPENDIX B

EXIT INTERVIEW – PROGRAM EVALUATION

Student #: ______________________

As you answer the interview questions, please reflect on your prior experiences in school and in the summer program, and how the program experiences potentially influenced the progress you have made in science.

1) What is your greatest strength in science since you participated in the program?

2) What is your greatest weakness in science that?

3) What science activities were the most challenging/difficult for you?

4) How would you describe your role among peers in this group in science?

5) What science topics/interests are most interesting to you since you participated in the program?

6) Describe science activities you have conducted?

7) Do you feel confident in your abilities to conduct science laboratory activities? Yes or no. Why or why not?

8) Describe how you feel when you engage in science activities.

9) Have your experiences in science met your expectations? Yes or no. Why or why not?

10) What would you like to change about your experiences in science?

11) Do you believe you are going to college? Yes or no. Why or why not?

12) What steps have you taken to prepare for college?

13) What steps have you taken to apply to college?

14) Have you been accepted to college? Yes or No or N/A. If you have been accepted to a college – name the college and your planned major.

15) Do you believe you are a youth leader in science? Yes or no. Why or why not?

16) What steps do you think you need to take to become a youth leader in science?

17) What impact did the science program experiences/activities have on your (1) science knowledge, (2) skills, (3) confidence to do science?

18) In cooperative groups each member plays a role or roles in science.

19) From the list provided, what was your task role/s in the science group activities in the program? Describe how your task role/s may have changed as a result of your experience in the program.

Task Roles

a. Initiator/Contributor

b. Information Seeker

c. Information Giver

d. Opinion Seeker

e. Opinion Giver

f. Elaborator/Clarifier

g. Coordinator

h. Diagnostician

i. Orienter/Summarizer

j. Energizer

k. Procedure Developer

l. Secretary

m. Evaluator/Critic

Check one or more

In School (√)

Exit Program (X)

20) Did you enjoy working in groups in the science program? Yes or no. Why or why not? Were your group experiences in the program different from those experiences in school?

21) What personal traits did you build as a result of your experiences in the program?

22) What science articles and/or books have you read in the last two months that have special meaning for you and why?

23) Where do you see yourself in 5 years? 10 years? Are your views or plans for the future changed since you participated in the program? Explain

24) What challenge did you face in the program and how did you overcome it? (It does not have to be science related)

25) What was the poster development and poster session experience like? What traits did you gain from both experiences?

26) Do you have any questions for the interviewer?

27) Do you have any additional comments that we did not cover in this interview that you would like to share?

28) What are your plans for the upcoming school year?

29) Have your views changed about engaging in science and science activities since your participation in program activities?

30) Describe how your interactions with (a) fellow scholars, (b) faculty advisors, and (c) mentors influence your science learning and achievement.

31) Describe one experience you had in the summer program that will be a positive influence in your life.

APPENDIX C

FOLLOW-UP INTERVIEW PROTOCOL

Hello Student #: ____________________

Thank you for agreeing to participate in my study and in this interview. I am conducting a dissertation study of The Lived Experiences of Underserved Students in a University Supplemental Science Program and Science Identity. I will ask you questions addressing your experiences, skills and knowledge in science in school prior to your enrollment in the supplemental science program, during and upon exiting the program, as well as how you may be applying these experiences, skills, and knowledge in your current educational environment and/or in your community/family life.

Your participation is voluntary and not a requirement for your enrollment in the program. You will not be penalized if you choose at any time not to participate or to withdraw from this study. Your responses will be confidential and there is minimal risk involved in participating in this study. You will be audio recorded during the interview to ensure accuracy in transcribing your responses to the questions. Do you have any questions in regard to this study or this interview?

So let's begin with the interview….

Interview Questions

School Science Experience

1. How would you describe yourself prior to entering the program?

Follow-up

a. In science

b. School

c. Life

d. Community

e. peers

2. Tell me about your experiences in science prior to entering the program.

Follow-up

a. Challenges

b. Strengths

c. Weaknesses

d. Peer interactions

e. General comments

Science Program and Post-Program Experience

3. Describe how you felt on the first day of the program.

Follow-up

a. First week of the program.

b. First two weeks of the program

c. During rotations

d. The first day of research

4. Describe challenges you encountered during the program. How did you address these challenges?

Follow-up

a. In science

b. With peers

c. With faculty/mentors

d. With staff

e. General comments

5. Tell me about your experiences during the program.

Follow-up

a. Rotations

b. Research

c. Laboratory

d. Field experiences

e. Poster session

6. Describe your relationship with your faculty advisor/mentor, staff, and peers in the program.

Follow-up

a. Challenges

b. Benefits

7. Describe new science skills and knowledge you gained as a result of your participation in the supplemental science program? How are you currently applying this new knowledge and skills in school/life?

Follow-up

a. School

b. Community

c. Life

8. How has your participation in the supplemental science program influenced you in science?

Follow-up

a. Learning

b. Postsecondary majors

c. Careers

d. Advocacy

e. Engagement

f. Interests/motivation/pursuit

g. What did you like the most about the supplemental science program?

h. What recommendations do you have to improve the program?

9. Describe your most gratifying experiences in the program.

Follow-up

a. What makes you proud?

b. What stood out?

10. Describe yourself after completing the program.

Follow-up

a. In science

b. In life

c. In goals

d. In career

e. For the future

Closing

1. Do you have any additional comments you would like to share concerning your experiences in the program and/or current experiences in your school or in your community?

Follow-up

a. Science

b. Peers

c. Careers

d. College majors

2. What advice would you give to a student currently participating in the science program?

APPENDIX D

PARENTAL LETTER OF CONSENT FOR MINORS

Dear Parent:

I am a graduate student under the direction of Professor Brian Beabout in the College of Education and Human Development, Department of Educational Leadership, Counseling, and Foundations at the University of New Orleans.

I am conducting a dissertation study about the experiences of students in a University Supplemental Science Program. I will ask your child questions addressing his/her experiences, skills and knowledge in science in school prior to his/her enrollment in the supplemental science program, during, and upon exiting the program, as well as how your child may be applying these experiences, skills, and knowledge in his/her current educational environment and/or in his/her community/family life. I am requesting your child's participation in a face-to-face follow-up interview that is expected to last approximately 60 minutes in duration. Your child's participation in this study is voluntary. If you choose not to have your child participate in this study or to withdraw your child from this study at any time, there will be no penalty.

Program evaluation data, including an exit interview and six weekly journals have already been collected as part of evaluating the supplemental science program. This parent permission is seeking your consent for your child to participate in the follow-up interview as part of this dissertation research study.

The results of the dissertation research study and program evaluation data acquired may be published, but your child's name will not be used. Possible benefits of your child's participation may be a greater understanding of his/her science learning and environmental health knowledge and skills. To maximize confidentiality, neither your child's name nor his/her school name will be used in any publications resulting from this research. The interview will be audio recorded and will be kept secure and will only be accessible by Brian Beabout and authorized assistants at the University of New Orleans. If you have any questions about this particular study, please contact Dr. Beabout at (504) 280-7388 or bbeabout@uno.edu and Lynette Dupre' Perrault at (504) 343-1055 or lperraul@uno.edu. If you have questions about your rights as a research participant, please contact Dr. Ann O'Hanlon (504) 280-3990 at the University of New Orleans.

By signing below you are giving permission for your child to participate in the dissertation research study.

________________________________ ________________________________

Parent/Legal Guardian (print name) Researcher (print name)

_

________________________________ ________________________________

Parent/Legal Guardian (sign) date Researcher (sign) date

Audio Recording

The dissertation research study involves audio recording of your child's interview. Neither your child's name nor other identifying information will be associated with the audio recordings or any transcripts created from them. Only the researchers will be permitted to listen to the recordings. The recordings will be transcribed by the researcher or a professional transcription service. After the interview, your child will be given the opportunity to have the recordings erased. I permit my child's participation to be recorded and transcribed into written form.

____

Parent/Legal Guardian (print name)

____

Parent/Legal Guardian (sign) date

If you have any questions about this particular study, please contact Dr. Beabout at (504) 280-7388 or bbeabout@uno.edu. If you have questions about your rights as a research participant, please contact Dr. Ann O'Hanlon (504) 280-3990 at the University of New Orleans.

APPENDIX E

CHILD ASSENT FORM

Dear Participant (Minor):

I am a graduate student under the direction of Professor Brian Beabout in the College of Education and Human Development, Department of Educational Leadership, Counseling, and Foundations at the University of New Orleans.

Your parents have given permission for you to participate in a dissertation research study about the experiences of students in a University Supplemental Science Program. I will ask you questions addressing your experiences, skills and knowledge in science in school prior to your enrollment in the supplemental science program, during, and upon exiting the program, as well as how you may be applying these experiences, skills, and knowledge in your current educational environment and/or in your community/family life. You will be asked to participate in a face-to-face follow-up interview that is expected to last approximately 60 minutes in duration.

Program evaluation data, including an exit interview and six weekly journals have already been collected from you as part of evaluating the supplemental science program. This child assent form is to confirm your participation in the follow-up interview as part of this dissertation research study. Your participation in this study is voluntary. If you choose not to participate in this study or to withdraw from this study at any time, there will be no penalty.

The results of the dissertation research study and program evaluation data acquired may be published, but your name will not be used. Possible benefits of your participation may be a greater understanding of your science learning and environmental health knowledge and skills. To maximize confidentiality, neither your name nor your school name will be used in any publications resulting from this research. The interview will be audio recorded and will be kept secure and will only be accessible by Brian Beabout and authorized assistants at the University of New Orleans. If you have any questions about this particular study, please contact Dr. Beabout at (504) 280-7388 or bbeabout@uno.edu and Lynette Dupre' Perrault at (504) 343-1055 or lperraul@uno.edu. If you have questions about your rights as a research participant, please contact Dr. Ann O'Hanlon (504) 280-3990 at the University of New Orleans.

I am participating in this dissertation research study because I want to. I know I can stop at any time I want to and it will be okay if I want to stop.

____________________________	____________________________
Participant (print name)	Researcher (print name)
____________________________	____________________________
Participant (sign) date	Researcher (sign) date

APPENDIX F

LETTER OF CONSENT FOR ADULTS

Dear Participant:

I am a graduate student under the direction of Professor Brian Beabout in the College of Education and Human Development, Department of Educational Leadership, Counseling, and Foundations at the University of New Orleans.

I am conducting a dissertation study about the experiences of students in a University Supplemental Science Program. I will you questions addressing your experiences, skills and knowledge in science in school prior to your enrollment in the supplemental science program, during, and upon exiting the program, as well as how you may be applying these experiences, skills, and knowledge in your current educational environment and/or in your community/family life. I am requesting you participation in a face-to-face follow-up interview that is expected to last approximately 60 minutes in duration. Your participation in this study is voluntary. If you choose not to participate in this study or to withdraw from this study at any time, there will be no penalty.

Program evaluation data, including an exit interview and six weekly journals have already been collected as part of evaluating the supplemental science program. This participant consent form is seeking your consent to participate in the follow-up interview as part of this dissertation research study.

The results of the dissertation research study and program evaluation data acquired may be published, but your name will not be used. Possible benefits of your participation may be a greater understanding of your science learning and environmental health knowledge and skills. To maximize confidentiality, neither your name nor your school name will be used in any publications resulting from this research. The interview will be audio recorded and will be kept secure and will only be accessible by Brian Beabout and authorized assistants at the University of New Orleans. If you have any questions about this particular study, please contact Dr. Beabout at (504) 280-7388 or bbeabout@uno.edu and Lynette Dupre' Perrault at (504) 343-1055 or lperraul@uno.edu. If you have questions about your rights as a research participant, please contact Dr. Ann O'Hanlon (504) 280-3990 at the University of New Orleans.

By signing below you are giving your consent to participate in the dissertation research study.

______________________________ ______________________________

Parent/Legal Guardian (print name) Researcher (print name)

________________________________ ________________________________

Parent/Legal Guardian (sign) date Researcher (sign) date

Audio Recording

The dissertation research study involves audio recording of your interview. Neither your name nor other identifying information will be associated with the audio recordings or any transcripts created from them. Only the researchers will be permitted to listen to the recordings. The recordings will be transcribed by the researcher or a professional transcription service. After the interview, you will be given the opportunity to have the recordings erased. I give my consent for my interviews to be recorded and transcribed into written form.

Parent/Legal Guardian (print name)

Parent/Legal Guardian (sign) date

If you have any questions about this particular study, please contact Dr. Beabout at (504) 280-7388 or bbeabout@uno.edu. If you have questions about your rights as a research participant, please contact Dr. Ann O'Hanlon (504) 280-3990 at the University of New Orleans.

APPENDIX G

University Committee for the Protection of Human Subjects in Research University of New Orleans

Campus Correspondence

Principal Investigator: Brian Beabout

Co-Investigator: Lynette Perrault

Date: March 22, 2017

Protocol Title: The Lived Experiences of Underserved Students in a University Supplemental Science Program and Science Identity

IRB#: 07Mar176

The IRB has deemed that the research and procedures are compliant with the University of New Orleans and federal guidelines. The above referenced human subjects protocol has been reviewed and approved using expedited procedures (under 45 CFR 46.116(a) category (7).

Approval is only valid for one year from the approval date. Any changes to the procedures or protocols must be reviewed and approved by the IRB prior to implementation. Use the IRB number listed on this letter in all future correspondence regarding this proposal.

If an adverse, unforeseen event occurs (e.g., physical, social, or emotional harm), you are required to inform the IRB as soon as possible after the event.

Best wishes on your project!
Sincerely,

Robert D. Laird, Ph.D., Chair
UNO Committee for the Protection of Human Subjects in Research

APPENDIX H

PARENTAL CONSENT FORM – TULANE UNIVERSITY

Principal Investigator: Jeffrey K. Wickliffe
Study Title: Towards Improving Environmental Health Literacy through Active Engagement in the Environmental Health Sciences
Performance Site: Tulane University School of Public Health and Tropical Medicine
Sponsor: Gulf Region Health Outreach Program

The following permission form is required by Tulane University for any research study conducted by investigators at the University with children under the age of 18. This study has been reviewed by the University's Institutional Review Board for Human Subjects.

Introduction

Your child is invited to participate in a research study to evaluate the potential impact of the Emerging Scholars Environmental Health Sciences Academy on high school students. Your child is being asked to participate because he/she is currently enrolled in the academy.

No research activity is to be conducted until you have had an opportunity to review this permission form, ask any questions you may have, and sign this document if applicable.

This permission form will give you the information you will need to understand why this study is being done and why your child is being invited to participate. It will also describe what your child will need to do to participate and any known risks, inconveniences or discomforts that he/she may have while participating. We encourage you to take some time to think this over and to discuss it with your family and friends. We also encourage you to ask questions now and at any time. If you decide to permit your child to participate, you will be asked to sign this form and it will be a record of your permission for him/her to participate. You will be given a copy of this form. This research study will enroll up to 15 participants.

Disclosure of Potential Conflict of Interest

The investigators in this study are also educators. They are interested in the knowledge to be gained from this study and in your child's well-being. Investigators may obtain salary or other financial support for conducting the research. Your child is under no obligation to participate in any research study offered to him/her.

Why is this study being done?

The purpose of this research study is to gain knowledge of the potential impact of the Emerging Scholars Environmental Health Sciences Academy on your child's environmental health science knowledge, skills and attitudes. A person's knowledge, skills and attitudes in environmental health sciences is known as environmental health literacy. We are also conducting this study to learn about your child's experiences with science learning and to evaluate the academy's content and logistics.

What are the study procedures? What will my child be asked to do?

If your child takes part in this study, he/she will be asked to participate in the following interviews, surveys, and reflective journal entries:

- Interviews: The interviews are 20–30 open-ended questions about your child's experiences with science learning and science identity. The interviews will take place in-person between your child and a researcher during the last week of the academy (exit interview) and about six weeks after the academy is finished (final interview). Both interviews will be audio recorded. Each interview will last from 30 to 60 minutes.

- Environmental Health Literacy (EHL) Survey: This paper-based survey evaluates your child's environmental health literacy after participation in the academy.

- Science Motivation Questionnaire II (SMQII) (pre & post-test): This paper-based survey asks your child to rate his/her science motivation before and after completing the academy research project.

- Science Process Skills Inventory (SPSI) (pre & post-test): This paper-based survey evaluates your child's science investigation skills before and after completing the academy research project.

- Changes in Attitude about the Relevance of Science (CARS) Questionnaire (pre, post & post-post-test): This paper-based survey evaluates your child's attitudes towards science before and after completing the academy research project, as well as six weeks after it finishes.

- Reflective Journal Entries: Your child will write a weekly reflective journal entry of about half a typed page each on your experiences at the academy and his/her interactions with mentors, field trip leaders, and other students. Each entry should take about 20 minutes to complete. Starting the fourth week of the academy, your child will receive an email each Wednesday prompt telling him/her to complete the entry. He/she should complete an entry within five days of receiving the prompt. He/she will receive guidance on the topic you should write about in each entry. For one of the entries, your child will be asked to look at some photos to remind him/her of experiences during the academy. No individuals or research participants will be present in the photos. All photos will be of locations and sites that your child visited or frequented during the academy, such as field trip sites or research laboratories at Tulane University.

- 2016 Scholar Academy Evaluation: This online survey asks your child to rate the academy's activities and content, such as field trips, laboratory rotations, seminars, and research projects. This survey will be completed in the final week of the academy.

- Scholar Evaluate Your Mentor: This online survey form asks your child to rate the quality of your mentor's advising during the academy. This survey will be completed in the final week of the academy.

Study Calendar

Most of the research will be conducted at Tulane University in the Tidewater building while your child is enrolled in the academy. If your child has access to a computer or mobile device, he/she can complete some of the study procedures outside of the university during non-academy hours. The last CARS questionnaire and the Final Interview will be administered in a public location about six weeks after the academy ends.

Procedure	Length of Time in Minutes	Where Procedure Will Occur	When Procedure Will Occur	How Administered
SMQII (pre-test)	10	2140 TDW	Academy Week 3, morning	Paper and pencil
SPSI (pre-test)	5	2140 TDW	Week 3, Morning	Paper and pencil
CARS Questionnaire (pre-test)	10	2140 TDW	Week 3, Morning	Paper and pencil
Reflective Journal Entries (5 entries)	20 minutes per entry, 100 mins	Unspecified	Weeks 4-8 (once per week)	Desktop computer or mobile device
2016 Scholar Academy Evaluation	5	Unspecified	Week 8	Desktop computer or mobile device
Scholar Evaluate Your Mentor	5	Unspecified	Week 8	Desktop computer or mobile device
SMQII (post-test)	10	2140 TDW	Week 8, Morning	Paper and pencil
SPSI (post-test)	5	2140 TDW	Week 8, Morning	Paper and pencil

CARS Questionnaire (post-test)	10	2140 TDW	Week 8, Morning	Paper and pencil
EHL Survey (post-test)	15	2140 TDW	Week 8, Morning	Paper and pencil
Exit Interview	30-60	2140 TDW	Week 8, morning	In-person with researcher, audiotaped
CARS Questionnaire (post-post-test)	10	Public Location	Week 14	Paper and pencil
Final Interview	30-60	Public Location	Week 14	In-person with researcher, audiotaped
Total Time Commitment	5 hours			

The procedures that will occur in an unspecified location can be completed online in the Tidewater building during the academy hours of 9 a.m. to 3 p.m. Monday through Friday, or they may be completed on your child's own time after 3 p.m. Monday through Friday or on weekends. He/she will receive an email prompt telling him/her to complete the procedures and they should be completed within five days of receiving the prompt.

The Final Interview and the last CARS Questionnaire will be completed in a public location; such as a public library or a coffee shop. A researcher will contact your child via text message or email to determine a date, time and location that is convenient for him/her to meet.

What are the risks or inconveniences of the study?

Your child may be at risk for a loss of privacy. A possible inconvenience may be the time it takes to complete the study.

What are the benefits of the study?

There will be no direct benefits to your child for participating in this research, but the knowledge gained from the study may improve the implementation of future academies. Anticipated benefits might include your child's greater understanding of his/her environmental health literacy and science learning.

Will my child receive payment for participation?
Your child will not be paid to be in this study.

Are there costs to participate?

There are no costs to your child to participate in this study.

How will my child's personal information be protected?

The following procedures will be used to protect the confidentiality of your child's data. The researchers will keep all study records (including any codes to the data) locked in a secure location. Research records will be labeled with a unique code. A master key that links names and codes will be maintained in a separate and secure location. All electronic files (e.g., database, spreadsheet, audio recordings etc.) containing identifiable information will be password protected. Any computer hosting such files will also have password protection to prevent access by unauthorized users. Only the members of the research staff will have access to the passwords. Data that will be shared with others will be coded as described above to help protect your child's identity. At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format and your child will not be identified in any publications or presentations. Any master key and other data described in this paragraph will be maintained in accordance with the security provisions of this paragraph until destroyed by the researchers five years after the study is completed.

Your child will access online study procedures through a link sent to him/her via email message by a software called Qualtrics.

You should also know that the Tulane University Human Research Protection Office and the Biomedical Institutional Review Board (IRB) may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your child's responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

Can my child stop being in the study and what are his/her rights?

You child does not have to be in this study if he/she does not want to. If he/she assents to be in the study, but later changes his/her mind, he/she may drop out at any time. There are no penalties or consequences of any kind if he/she decides not to participate.

Your child does not have to answer any question that he/she does not want to answer in any of the study procedures (for example, interviews, surveys, reflective journals).

Your child may be withdrawn from the study at any time due to missed days, non- adherence to procedures, and/or disruptive behavior during study procedures.

Who do I contact if I have questions about the study?

Take as much time as you like before you make a decision to provide permission for your child participate in this study. We will be happy to answer any question you have about this study. If you have further questions about this study, want to voice concerns or complaints about the research or if you have a research-related problem, you may contact the Principal Investigator, Jeffrey K. Wickliffe @ 504-988-3910, or the Study

Coordinator, Lynette D. Perrault @ 504-988-0961, or the Study Coordinator, Hannah H. Covert @ 504-988-9035. If you would like to discuss your child's rights as a research participant, discuss problems, concerns, and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research, you may
contact the Tulane University Human Research Protection Office at 504-988-2665 or email at irbmain@tulane.edu.

Consent to Audiotape

This study involves audio recording of your child's interviews. Neither your child's name nor any other identifying information will be associated with the audio recordings or any transcripts created from them. Only the researcher(s) will be permitted to listen to the recordings.

Immediately following each interview, you child will be given the opportunity to have the recordings erased.

Please initial one of each pair of options.

___I permit my child's participation to be recorded.
___I do not permit my child's participation to be recorded

___I permit my child's recorded participation to be transcribed into written form.
___I do not permit my child's recorded participation to be transcribed.

The recordings will be transcribed by the researcher or a professional transcription service and erased once the transcriptions are checked for accuracy. Transcripts of your child's participation may be reproduced in whole or in part for use in presentations or written products that result from this study. Neither your child's name nor any other identifying information (such as his/her voice) will be used in presentations or in written products resulting from the study.

_________I permit the use of the written transcription in presentations and written products resulting from the study provided that neither my child's name nor other identifying information will be associated with the ____I do not permit the use of my child's written transcription in presentations or written products resulting from the study.

The above permissions are in effect until June 1, 2021. On or before that date, the tapes will be destroyed.

____ ______________
Signature of Parent/Legally Authorized Representative Date

Documentation of Consent:

I have read this form and decided that I will permit my child to participate in the research project described above. Its general purposes, the particulars of involvement and possible risks and inconveniences have been explained to my satisfaction. I understand that my child can withdraw at any time. My signature also indicates that I have received a copy of this permission form.

1. I give permission for my child to be contacted for future research studies.

___________ I agree
___________ I do not agree

2. I understand that, as a result of my child's participation in this research study, at the end of the study the investigator may use email or text messaging to establish his/her living status, for statistical purposes required to validate his/her participation in this study.

____ _____________
Parent/Legally Authorized Representative (if applicable) Date

____ _____________
Person Obtaining Permission Date

I am unable to read but this permission document has been read and explained to me by ____________________ (name of reader). My child may participate in this research.

____ _____________
Parent/Legally Authorized Representative Date

____ _____________
Witness Date

____ _____________
Person Obtaining Permission Date

____ _____________
Principal Investigator Signature Date

APPENDIX I

CHILD ASSENT FORM – TULANE UNIVERSITY

Principal Investigator: Jeffrey K. Wickliffe
Study Title: Towards Improving Environmental Health Literacy through Active Engagement in the Environmental Health Sciences
Performance Site: Tulane University School of Public Health and Tropical Medicine
Sponsor: Gulf Region Health Outreach Program

The following assent form is required by Tulane University for any research study conducted by investigators at the University. This study has been reviewed by the University's Institutional Review Board for Human Subjects.

Who are we and why are we meeting with you?

We want to tell you about a research study we are doing. A research study is a way to learn information about something. We would like to find out more about the potential impact of the Emerging Scholars Environmental Health Sciences Academy on high school students. You are being asked to join the study because you are currently a student in the academy. This research study will have up to 15 participants.

What will happen to me in this study?

We are completing this research study to gain information about the impact of the Emerging Scholars Environmental Health Sciences Academy on your environmental health science knowledge, skills and attitudes. Your knowledge, skills and attitudes in environmental health sciences is known as your environmental health literacy. We are also conducting this study to learn about your experiences with science learning and to evaluate the academy's content and programming.

If you agree to be part of this study, you will be asked to complete the following interviews, surveys, and reflective journal entries:

- Interviews: The interviews are 20–30 open-ended questions about your experiences with science learning and science identity. The interviews will take place in-person between you and a researcher during the last week of the academy (exit interview) and about six weeks after the academy is finished (final interview). All interviews will be audio recorded. Each interview will last from 30 to 60 minutes.

- Environmental Health Literacy (EHL) Survey: This paper-based survey evaluates your environmental health literacy after participation in the academy.

- Science Motivation Questionnaire II (SMQII) (pre & post-test): This paper-based survey asks you to rate your science motivation before and after completing the academy research project.

- Science Process Skills Inventory (SPSI) (pre & post-test): This paper-based survey evaluates your science investigation skills before and after completing the academy research project.

- Changes in Attitude about the Relevance of Science (CARS) Questionnaire (pre, post & post-post-test): This paper-based survey evaluates your attitudes towards science before and after completing the academy research project, as well as six weeks after it finishes.

- Reflective Journal Entries: You will write a weekly reflective journal entry of about half a typed page each on your experiences at the academy and your interactions with mentors, field trip leaders, and other students. Each entry should take about 20 minutes to complete. Starting the fourth week of the academy, you will receive an email prompt each Wednesday telling you to complete the entry. You should complete an entry within five days of receiving the prompt. You will receive guidance on the topic you should write about in each entry. For one of the entries, you will be asked to look at some photos to remind you of experiences during the academy. No individuals or other academy participants will be in the photos. All photos will be of locations and sites that you visited or frequented during the academy, such as field trip sites or research laboratories at Tulane University.

- 2016 Scholar Academy Evaluation: This online survey asks you to rate the academy's activities and content, such as field trips, laboratory rotations, seminars, and research projects. This survey will be completed in the final week of the academy.

- Scholar Evaluate Your Mentor: This online survey form asks you to rate the quality of your mentor's advising during the academy. This survey will be completed in the final week of the academy.

Study Calendar

Most of the study will be conducted at Tulane University in the Tidewater building while you are enrolled in the academy. If you have access to a computer or mobile device, you can complete some of the surveys or journal entries outside of the university during non-academy hours. You will complete the last CARS questionnaire and the Final Interview with one of the researchers in a public location about six weeks after the academy ends.

Procedure	Length of Time in Minutes	Where Procedure Will Occur	When Procedure Will Occur	How Administered
SMQII (pre-test)	10	2140 TDW	Academy Week 3, morning	Paper and pencil
SPSI (pre-test)	5	2140 TDW	Week 3, morning	Paper and pencil
CARS Questionnaire (pre-test)	10	2140 TDW	Week 3, morning	Paper and pencil
Reflective Journal Entries (5 entries)	20 minutes per entry, 100 mins	Unspecified	Weeks 4-8 (once per week)	Desktop computer or mobile device
2016 Scholar Academy Evaluation	5	Unspecified	Week 8	Desktop computer or mobile device
Scholar Evaluate Your Mentor	5	Unspecified	Week 8	Desktop computer or mobile device
SMQII (post-test)	10	2140 TDW	Week 8, morning	Paper and pencil
SPSI (post-test)	5	2140 TDW	Week 8, morning	Paper and pencil
CARS Questionnaire (post-test)	10	2140 TDW	Week 8, morning	Paper and pencil
EHL Survey (post-test)	15	2140 TDW	Week 8, morning	Paper and pencil
Exit Interview	30-60	2140 TDW	Week 8, morning	In-person with researcher, audiotaped
CARS Questionnaire (post-post-test)	10	Public Location	Week 14	Paper and pencil
Final Interview	30-60	Public Location	Week 14	In-person with researcher, audiotaped
Total Time Commitment	5 hours			

The parts of the study that will occur in an unspecified location can be completed online in the Tidewater building during the academy hours of 9 a.m. to 3 p.m. Monday through Friday, or they may be completed on your own time after 3 p.m. Monday through Friday or on weekends. You will receive an email prompt telling you to complete the procedures and they should be completed within five days of receiving the prompt.

The Final Interview and the last CARS Questionnaire will be completed in a public location; such as a public library or a coffee shop. We will contact you via text message or email to determine a date, time and location that is convenient for you to meet.

Can anything bad happen to me?

You may lose some privacy by being in this study. You may be bothered by the amount of time it will take to complete this study. If you have any discomfort because of this study, you should inform your parents/guardians.

Can anything good happen to me?

There are no direct benefits to you for participating in this study. We do not know if you will be helped by being in this study. You may gain information about your environmental health literacy and your science learning. We may learn something that will help other high school students who participate in the academy in the future.

Will anyone know I am in the study?

We will not tell anyone you are participating in this study. We may give the information you provide to other people or to other organizations, but your name will not be attached to your information and we will not tell anyone that you provided it. Your name will not
be in any report of the results of this study.

Will I be given anything to take part in this study?

You will not receive anything for being in this study.

Who can I talk to about the study?

You can ask us questions at any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else at any time during the study.

If you have any questions about the study or any problems with the study, you can call the Principal Investigator Jeffrey Wickliffe. You can call him at 504-988-3910. You can also call Lynette Perrault, a Study Coordinator, at 504-988-0961 or Hannah Covert, a Study Coordinator, at 504-988-9035.

If you have any questions about the study but want to talk to someone who is not part of the study, you can call the Tulane University Human Research Protection Office (HRPO) at (504) 988-2665.

What if I do not want to do this?

You don’t have to be in this study if you do not want to. No one will get angry or upset if you don’t want to be in this study. Just tell us. And remember, you can change your mind later if you decide you don’t want to be in this study anymore. You can drop out at any time. You do not have to answer any question you do not want to answer during any part of the study.

Consent to Audiotape

This study involves audio recording of your interviews. Neither your name nor any other identifying information will be associated with the audio recordings or any transcripts created from them. Only the researcher(s) will be permitted to listen to the recordings.

After each interview, you will be given the opportunity to have the recordings erased.

Please initial one of each pair of options.

___I consent to have my participation recorded.
___I do not consent to have my participation recorded

___I consent to have my recorded participation transcribed into written form.
___I do not consent to have my recorded participation transcribed.

The recordings will be transcribed by the researchers or a professional transcription service and erased once the transcriptions are checked for accuracy. Transcripts of your participation may be reproduced in whole or in part for use in presentations or written products that result from this study. Neither your name nor any other identifying information (such as your voice) will be used in presentations or in written products resulting from the study.

___I consent to the use of the written transcription in presentations and written products resulting from the study provided that neither my name nor other identifying information will be associated with the transcript.

___I do not consent to the use of my written transcription in presentations or written products resulting from the study.

The above permissions are in effect until June 1, 2021. On or before that date, the tapes will be destroyed.

______________________________________ ____________
Signature of Participant Date

Signature

If you understand this study and you are willing to participate, please sign below:

____

Subject Name

___________________________________ ____________

Subject Signature Date

I am unable to read but this consent document has been read and explained to me by ________________(name of reader). I volunteer to participate in this research.

___________________________________ ____________

Subject Date

___________________________________ ____________

Witness Date

<u>Signature of Investigators or Responsible Individual:</u>

“To the best of my ability, I have explained and discussed the full contents of the study, including all of the information contained in this consent form. All questions of the research subjects and those of his/her parent(s) or legal guardian have been accurately answered.”

____

Investigator/Person Obtaining Consent Name

___________________________________ ____________

Signature Date

APPENDIX J

Tulane Human Research Protection Program
Institutional Review Boards
Biomedical
Social Behavioral
FWA00002055

DATE: October 4, 2016

TO: Jeffrey Wickliffe, B.S., M.S.,
Ph.D. FROM: Tulane University Biomedical IRB

STUDY TITLE: [758443-2] Towards Improving Environmental Health Literacy Through Active Engagement in the Environmental Health Sciences

IRB REFERENCE #: 16-758443
SUBMISSION TYPE: Amendment/Modification

ACTION: **APPROVED**
EFFECTIVE DATE: October 4, 2016
EXPIRATION DATE: June 20, 2017

Thank you for submitting the amendment to the above referenced study. The Tulane IRB approved your submission including:

- Amendment/Modification - Amendment Form 9-28-16 version 2 (UPDATED: 10/3/2016)
- Cover Sheet - Cover Sheet-Letter Wickliffe EHL Scholars 2016 v5 (UPDATED: 09/28/2016)
- Protocol - Protocol 9-28-16 version 2 clean (UPDATED: 10/3/2016)
- Protocol - Protocol 9-28-16 version 2 marked up (UPDATED: 10/3/2016)
- Training/Certification - CITI Group 1 L. Soares (UPDATED: 09/28/2016)
- Tulane - Application for Human Subjects Research, Part 1 - Tulane - Application for Human Subjects Research, Part 1 (UPDATED: 09/28/2016)

In accordance with 45 CFR 46.110(b)(1), the Tulane University Social/Behavioral IRB has provided an expedited review and grants approval for the addition of Lissa Soares to the study team.

Criteria for IRB approval of research continues in accordance with 45 CFR 46.111(a)(1-7). Children may be enrolled in research not involving greater than minimal risk in accordance with 45 CFR 46.404, and adequate provisions are made for soliciting the assent of the children and permission of their parents or guardians, as set forth in §46.408.

If there are any pending approvals from any other institutions or research oversight committees, research activity cannot commence until all such approvals have been obtained. The PI is to provide the Tulane IRB via IRBNet copies of all approval letters as received. This includes: Tulane Institutional Biosafety approval (when applicable); Tulane Radiation Safety Committee approval (when applicable); and any other committee approvals required by the University. Additionally, for sponsored research, the research cannot commence until the Sponsored Research Agreement has been fully executed.

If you have any questions, please contact the HRPO at (504) 988-2665 or irbmain@tulane.edu.

Sincerely,
Tulane University Human Research Protections Office
1440 Canal St, Suite 1705, TW-8436
New Orleans, LA 70112

Please note that the actual signature by the IRB Chair(s) is not required for this document to be effective since it is generated by IRBNet pursuant to the IRB Chair's electronic signature and approval. This process is consistent with Federal Regulations and Tulane standard operating policies with respect to
the IRB and Human Research Protection Office, which consider electronically generated documents as official notice to sponsors and others of approval, disapproval or other IRB decisions. Please refer to the HRPO website at http://tulane.edu/asvpr/irb to refer to Tulane's Electronic Signatures and Records Policy.

APPENDIX K

Tulane Human Research Protection Program
Institutional Review Boards
Biomedical
Social Behavioral
FWA00002055

DATE:	June 12, 2017
TO:	Jeffrey Wickliffe, B.S., M.S.,
Ph.D. FROM:	Tulane University Bio-medical IRB
STUDY TITLE:	[758443-3] Towards Improving Environmental Health Literacy Through Active Engagement in the Environmental Health Sciences
IRB REFERENCE #:	16-758443
SUBMISSION TYPE:	Continuing Review/Progress Report
ACTION:	**APPROVAL**
APPROVAL PERIOD:	June 21, 2017 - June 20, 2018

Thank you for your recent continuing review submission. The Tulane University Institutional Review Board has approved your submission.

This approval is based on an appropriate risk/benefit ratio and a study design where the risks have been minimized. All research must be conducted in accordance with this approved submission.

The following items were included in this submission:

- Child Assent - completed assent form 2 redacted.pdf (UPDATED: 05/24/2017)
- Child Assent - completed assent form 1 redacted.pdf (UPDATED: 05/24/2017)
- Child Assent - Child Assent 5-24-17 marked up.docx (UPDATED: 05/24/2017)
- Child Assent - Child Assent 5-24-17 clean.docx (UPDATED: 05/24/2017)
- Continuing Review/Progress Report - Continuing Review Form Wickliffe 758443 v3.docx (UPDATED: 05/25/2017)
- Cover Sheet - Cover Letter Wickliffe 758443 Continuing Review v2.docx (UPDATED: 05/24/2017)
- Other - Secondary Submission Checklist for Wickliffe 758443 Continuing Review.docx (UPDATED: 05/19/2017)
- Parental Permission Form - completed permission form 1 redacted.pdf (UPDATED: 05/24/2017)

- Parental Permission Form - completed permission form 2 redacted.pdf (UPDATED: 05/24/2017)
- Parental Permission Form - Parental Permission Form 5-24-17 marked up.docx (UPDATED: 05/24/2017)
- Parental Permission Form - Parental Permission Form 5-24-17 clean.docx (UPDATED: 05/24/2017)
- Protocol - Protocol 5-24-17 marked up v2.docx (UPDATED: 05/25/2017)
- Protocol - Protocol 5-24-17 clean v2.docx (UPDATED: 05/25/2017)

- Tulane - Application for Human Subjects Research, Part 1 - Tulane - Application for Human Subjects Research, Part 1 (UPDATED: 05/19/2017)

The Tulane University Social-Behavioral IRB has granted approval for the continuation of the above referenced study in accordance with 45 CFR 46.110(b)(1), research categories 6 and 7.

Criteria for IRB approval of this research is in accordance with 45 CFR 46.111, 21 CFR 56.111, and 21 CFR 50 (If FDA regulated).

Criteria for IRB approval of research is in accordance with 45 CFR 46.111(a)(1-7). Children may be enrolled in research not involving greater than minimal risk in accordance with 45 CFR 46.404, and adequate provisions are made for soliciting the assent of the children and permission of their parents or guardians, as set forth in §46.408.

The IRB approves the following changes in this submission: an increase in subject enrollment from 15 to 29; and corresponding changes to the protocol, consent, and assent forms.

The IRB acknowledges the events describing the separate dates for which assent and parental permission for a subject were obtained; and the event describing a study team member failing to document her signature at the time of subject assent and parental permission. Neither of these events involved increased risk or harm to the subject. These issues are determined by the IRB to be resolved.

The IRB has approved the enrollment of 29 subjects who are participants in Tulane University's Emerging Scholars Environmental Health Sciences Academy. The PI reports that 9 subjects have been enrolled to date.

The Tulane University IRB approved and stamped Consent/Assent documents are to be utilized when enrolling subjects. This study is granted an approval period of June 21, 2017 - June 20, 2018.

Proposed changes to the research, including enrollment of additional study participants, must be submitted to the IRB for review and approval prior to implementation, unless a change is necessary to avoid immediate harm to subjects.

Please remember that informed consent is a process beginning with a description of the study and assurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study with dialogue between the Investigator and research participant. Federal regulations require each participant to receive a copy of their signed consent form unless this requirement has been waived by the IRB.

Any unanticipated problems involving risk to subjects or others, deviations from the approved research, non-compliance, and complaints must be reported to the IRB in accordance with Tulane HRPP policies and procedures. If this study includes ongoing oversight by a Data Safety Monitoring Board (DSMB) or other such committee, reports generated by the DSMB or oversight committee must be submitted to the IRB.

Continuations must be submitted in accordance with Tulane HRPP policies and procedures. 45 CFR 46.109(e) states that an IRB must conduct a continuing review of research at intervals appropriate to the degree of risk, but not less than one year. The federal regulations provide for no grace period. Failure to obtain approval for continuation of your study prior to the expiration date will require discontinuation of all research activities for this study, including enrollment of new subjects.

When all study activities and data analysis have been completed, please notify the IRB within 30 days of such completion by submitting a Study Closure Form.

This research study will expire on June 20, 2018. As per federal regulations and Tulane HRPP policy, this study will be administratively closed 30 days after the expiration date, if approval for continuation of this study has not been granted.

If you have any questions, please contact the HRPO at (504) 988-2665 or irbmain@tulane.edu.

Sincerely,
Tulane University Human Research Protections Office
1440 Canal St, Suite 1705, TW-8436
New Orleans, LA 70112

Please note that the actual signature by the IRB Chair(s) is not required for this document to be effective since it is generated by IRBNet pursuant to the IRB Chair's electronic signature and approval. This process is consistent with Federal Regulations and Tulane standard operating policies with respect to the IRB and Human Research Protection Office, which consider electronically generated documents as official notice to sponsors and others of approval, disapproval or other IRB decisions. Please refer to the HRPO website at http://tulane.edu/asvpr/irb to refer to Tulane's Electronic Signatures and Records Policy.

Vita

Lynette Dupre’ Perrault was born and raised in New Orleans, Louisiana. Perrault is currently the Director of Training and Educational Leadership in the Tulane School of Public Health and Tropical Medicine, where she leads a summer science academy for high schools students, and a teacher workshop. Perrault’s past career experiences were in Orleans Parish Public Schools where she served as a special education teacher, itinerant teacher, and special education director. Prior to working in the school system she worked in the public relations field for a non-profit educational foundation. Perrault earned her Bachelor of Arts degree in Communications and Sociology from Loyola University and three degrees from the University of New Orleans: Master of Education in Special Education/Mild Moderate 1^{st}-12^{th} Grades, a Master of Education in Educational Leadership, and a PhD in Educational Administration K-12 Concentration.