Beyond the Classroom: The Impact of Informal STEM Experiences on Student Attitudes and Interest

A dissertation submitted in partial satisfaction of the requirements for the degree of Doctor in Education in Doctor of Education in Educational Leadership by Lidia Scinski

Committee in charge:
California State University, San Marcos
Katherine Hayden, Chair
Moses Ochanji
University of California, San Diego
Carolyn Hofstetter

2014
The Dissertation of Lidia Scinski is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Chair

University of California, San Diego

California State University, San Marcos

2014
DEDICATION

I dedicate this dissertation to my parents (Guillermina and Antonio Carlos), my husband (William H. Scinski), my children (Pablo A. Solis, Desiree Scinski, and William A. Scinski), and minority children. Acquiring this doctoral degree has been one of the most difficult tasks I’ve ever completed in my life. It has taken over seven years, countless hours of work, and many tears. I definitely could not have achieved this without the love, support, and patience of my family. My passion and perseverance stems from the relentless encouragement from my parents that education is the great equalizer. They assured me that if I educated myself in the United States I could be somebody and make a difference for others. My husband’s encouraging words, “never give up” and “you can do this,” pushed me to continue moving forward during difficult times, and there were many. As I’m finishing this last leg, I want my own children and other minority children to see themselves in me and believe that they too can acquire a doctoral degree if they so wish. I thank my parents for their struggles in bringing us to this county so that we can achieve our dreams. I also thank my family for their sacrifices in this journey.
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VITA

EDUCATION

University of California, San Diego
California State University, San Marcos
  Doctor of Education in Educational Leadership, 2014

San Diego State University, San Diego
  Master of Arts in Educational Leadership, 2003

San Diego State University, Calexico
  Bachelor of Arts in Liberal Studies, Bilingual/Bicultural Spanish Education, 1994

Imperial Valley College, Imperial
  No degree, transferred to San Diego State University

CREDENTIALS

San Diego State University, San Diego
  Clear Administrative Services Credential, 2004

San Diego State University, San Diego
  Professional Clear Multiple Subject Teaching Credential, 1995
  BCLAD Emphasis: Spanish
  Supplementary: Mathematics and English

CAREER HISTORY

Harriet Tubman Village Charter School-authorized by San Diego Unified School District
  Principal, Harriet Tubman Village Charter School: 2009-Present

San Marcos Unified School District
  Assistant Principal, San Marcos Middle School: 2007-2009

Fallbrook Unified School District
  Assistant Principal, La Paloma Elementary School: 2006-2007

Hemet Unified School District
  Assistant Principal, Acacia Middle School: 2005-2006

San Marcos Unified School District
  Poway Unified School District
  Department of Defense, Roosevelt Roads, Puerto Rico
  Imperial Unified School District
El Centro Union School District  
Middle School Mathematics Teacher: 1994-2005  

PUBLICATIONS  

ABSTRACT OF THE DISSERTATION

Beyond the Classroom:  
The Impact of Informal STEM Experiences on Student Attitudes and Interest

by

Lidia Scinski

Doctor of Education in Educational Leadership

University of California, San Diego, 2014  
California State University, San Marcos, 2014

Professor Katherine Hayden, Chair

A lack of social capital can be a critical factor impeding underrepresented minority (URM) students from obtaining the mathematical and scientific background required to achieve educational and career success in STEM fields. In this study, the effects of generating and utilizing social capital within an informal STEM outreach summer camp are examined as resources in strengthening the academic pipeline for Hispanic students towards careers in STEM. Empirical studies have shown that economically disadvantaged and minority students experience larger learning losses during “unschooled” periods of time than their middle-class and White counterparts. The “faucet theory” explains how the achievement gap widens during unschooled periods of time when the resource faucet is turned off and families of students from disadvantaged backgrounds are unable to make up for these resources. Consequently, minority and
students of disadvantaged backgrounds are quickly shortcircuited in taking advantage of opportunities to pursue careers in STEM fields.

To address the research questions, this study employed a qualitative research design, specifically an instrumental case study design using mixed methods within a bounded program. The methods included multiple measures to collect and analyze data from focus group interviews, electronic documents, observations, and survey administrations. The sample population included forty-nine Hispanic 7th and 8th grade students from middle schools in San Diego County.

Results of the study demonstrated that the informal STEM outreach summer camp positively impacted Hispanic students and increased interest and attitudes toward STEM choices. STEM programs offered during out-of-school time need to be relationship based to support young students’ social and emotional development (Goldstein, Lee, & Chung, 2010). The resource faucet continued to flow during the summer for iQUEST science camp participants because they were able to tap into social capital in the surrounding community. More specifically, participants were able to generate social capital in two key forms of institutional support: “funds of knowledge” and “emotional and moral support”.
CHAPTER 1: INTRODUCTION

A well-publicized concern in the United States today is the fact that minorities and women are highly underrepresented in Science, Technology, Engineering, and Mathematics (STEM) fields (Howard, K. Calstrom, A., & Solberg, V.S. 2009; Jayaratne, Thomas, & Trautmann, 2003; Morrell, Cotton, Sparks & Spurgas, 2004; NSB, 2006; NSF, 2013; Stake & Mares, 2000; Taningco, Mathew, & Pachon, 2002). In the digital age, developing a technologically literate workforce is essential. Therefore, lack of math, science, and technology skills will negatively impact women’s and minorities’ chances to compete for employment, wages, and leadership in all professional fields (Oakes, 1990; Ramsey & Baethe, 2013). Education groups such as the National Science Foundation (NSF) and the National Action Council for Minorities in Engineering (NACME) are calling this under representation “America’s Pressing Challenge” and “The New American Dilemma.” Leading businesses and education groups have teamed up and aimed new initiatives at increasing the number of minorities and women in STEM fields. Moreover, the Tomas Rivera Policy Institute (TRPI) released a publication addressing the pressing need for Hispanics in STEM professions titled, “STEM Professions: Opportunities and Challenges for Latinos” (TRIP, 2002).

According to data from the U.S. Census Bureau (2010), Hispanics are the fastest growing minority group; they constitute 16% of the nation’s population and are relatively young, at a median age of 27 years. Between 2000 and 2010, more than half of the United States’ total population increase was due to growth of Hispanic population. The Hispanic population residing in the U.S. has more than doubled since 1990. At this rate, Hispanics will make up more than 30% of the nation’s population by the year 2050.
Given the projected high demands in STEM fields and current initiatives to increase minorities’ participation, Hispanics have unprecedented opportunities to strive for STEM careers. Of special interest is the persistent disparity in the number of Hispanics attracted to careers in STEM fields. According to a report released by the National Science Board (2012), Hispanic representation in science and engineering occupations increased from 3.4% in 1999 to 4.9% in 2008, which is proportionally less than their increase in population from 2000 to 2010. The U.S. Census Bureau 2010 report released in May of 2011, states, “Between 2000 and 2010, the Hispanic population grew by 43 percent, which was four times the growth of the total population at 10 percent” (p. 2). Changes in today’s workforce along with the U.S. Bureau of Labor Statistics expectations of job growth of 22% by 2014 in STEM fields (Therrien & Ramirez, 2000) will require that our youth obtain sophisticated skills in such areas. Hector Ruiz, CEO for IBM, states “fostering STEM skills is critically important in developing an adept workforce to fill the jobs of this expanding digital economy” (2008, p. 2).

Recent data from the National Assessment of Educational Progress (NAEP, 2013) suggest that a significant difference continues to exist in the number of Hispanic and White students scoring “proficient or advanced” in reading, math, and science. NAEP (2013) data report that there is a 24-point gap in average reading scores between White and Hispanic students in eighth grade. In the same study only 22% of eighth grade Hispanic students scored advanced or proficient in reading assessment compared to 46% of White students. At 24-points, the White-Hispanic gap in mathematics remained constant from 2011 (NEAP, 2013). In 2011, the White-Hispanic national gap narrowed
in science, but a 29-point gap still exists. These statistics are clear indicators that Hispanic youth are lagging behind their White counterparts and, therefore, are not prepared for higher level, rigorous curriculum in the areas of reading, math, and science.

Unfortunately, the Hispanic-White achievement gap is present long before children start school and research on seasonal learning shows that non-school factors affect achievement of economically disadvantaged and minority students (Alexander, Entwisle, & Olsen, 2001; Gandara, 2006; Ream, Ryan, & Espinoza, 2012; Rock & Stenner, 2005). Multiple empirical studies have shown that economically disadvantaged and minority students experience larger learning losses during “unschooled” periods of time than their middle-class and White counterparts. Alexander, Entwisle, and Olson (2001) refer to the “faucet theory” as a reason why the gap widens for disadvantaged minority students. In short, “faucet theory” says that during schooled periods all students benefit from school resources and equally make academic growth, but during unschooled periods this faucet is turned off and families of low socio-economic status are unable to make up for lost resources. In order to increase the number of Hispanic students who leave K-12 prepared to pursue careers in STEM fields, these findings cannot be ignored. Gandara (2001) states, “students from disadvantaged schools and backgrounds almost certainly need more time to catch up to their more advantaged peers and more scaffolding along the way to support their learning” (p. 231). Hence, her recommendation to educational leaders and policy makers is that in order to level the playing field and strengthen the academic pipeline to careers in STEM for Hispanic students, we must “provide a seamless web of support and enrichment for those students whose families cannot provide the resources” (p. 234).
The underrepresentation of minorities in STEM has given rise to interventions in out-of-school time and settings provided by local businesses, universities, recreational parks, museums, science research centers, and community organizations (Bell, Lewenstein, Shouse & Feder, 2009). In 1988, the U.S. Congress published a report acknowledging the need for informal education and intervention programs in order to enhance the STEM pipeline in our country:

The out-of-school environment offers opportunities to enhance students’ appreciation of science and mathematics or to give them “second chances” in these areas, regardless of test-determined abilities. Programs outside of school can be both alternatives and complements to school activities. (Educating Scientist and Engineers: Grade School to Grad School, p. 36)

Thus, summer is a critical time for intervening and providing economically disadvantaged youth with opportunities and resources their families cannot afford.

**Statement of Problem**

There is a disparity in the number of Hispanic students attracted to careers in STEM fields as compared to their White counterparts. It is an unfortunate reality that fewer students, especially minorities, are choosing to pursue careers in STEM fields. For Hispanic students, it is an even sadder case in that they are short changed of this option prior to completing middle school (Oakes, 2005). Consequently, NACME (2008) refers to the “4% problem” meaning that only 4% of underrepresented minorities graduate from high school having met criteria to be “engineering eligible.” Leaders and policy makers cannot ignore these data. Moreover, they need to also understand that diversity drives innovation, which is crucial for competing in today’s global economy (Forbes, 2011). Dr. John Brooks Slaughter (2008), President and CEO of NACME, urges that:
Given that the number of college-age minority students will grow dramatically over the next decade, and that significant gaps in college participation and success exist between them and their non-minority peers, we must find ways to facilitate, rather than deter, their entry into and graduation from STEM disciplines. (p. 5)

Additionally, there is a lack of social capital impeding underrepresented minority (URM) students from obtaining the mathematical and scientific background required to achieve educational and career success in STEM fields. Social capital, as used in this study, is founded on Stanton-Salazar and Dornbusch’s (1995) definition, “social relationships from which an individual is potentially able derive institutional support, particularly support that includes the delivery of knowledge-base resources” (p. 119). Given that Hispanic youth are least likely to pursue STEM choices, it is critical that STEM opportunities are relationship based, not just workforce driven. For example, one of the core design elements of the successful Chicago-based project called Project Exploration was to build social capital through creating relationships between students and passionate STEM professionals (Lyon, Jafri, & St. Louis, 2012). The program’s STEM learning experiences are designed to support students’ social and emotional development by intentionally structuring relationships among students, staff, and scientists. According to Chi, Goldstein, Lee, and Chung (2010), “Meaningful work with scientists and long-term relationships with caring adults were critical factors in students’ decisions to persist in Project Exploration and in STEM” (p. 50). STEM outreach programs that capitalize on relationships with scientists and institutional partnerships will ensure that students build the social capital needed to strengthen the science pipeline (Lyon, Jafri, & St. Louis, 2012).
Rationale for the Study

A close review of the literature revealed that minimal empirical studies have examined the development of social capital among Hispanic youth participating in academic settings outside of school or in specific academic disciplines such as mathematics and science. Therefore, there is a need for research that examines the effects of generating and utilizing social capital within academic outreach programs as resources for strengthening the academic pipeline for Hispanic students in order to ensure their success in STEM careers. Additionally, this study could contribute to a more comprehensive understanding of the role institutional agents and interpersonal networks play in influencing Hispanic students’ STEM choices. STEM choices refers to middle school students expressing a desire to enroll in higher level math and science classes, achieving good grades, and taking on leadership roles in such classes. Social capital, as used in this study, is founded on Stanton-Salazar and Dornbusch’s (1995) definition: “social relationships from which an individual is potentially able to derive institutional support, particularly support that includes the delivery of knowledge-based resources; for example, guidance for college admission or job advancement” (p. 119). Stanton-Salazar (1997) describes institutional support in terms of six key forms as follows:

1) Provision of various funds of knowledge (i.e., institutional sanctioned discourse, academic task-specific knowledge, organizational/bureaucratic knowledge, network development, technical, knowledge of labor and educational markets, and problem solving); 2) bridging, or the process of acting as a human bridge to gatekeepers, to social networks and to opportunities for exploring various “mainstream” institutions (i.e., university campuses); 3) advocacy and related forms of personalized intervention; 4) role modeling; 5) provision for emotional and moral support; 6) provision of regular, personalized, and soundly based evaluative feedback, advice, and guidance (p. 11)
Since institutional agents are typically well positioned to empower students with key forms of social and institutional support, students of low-status depend on institutional agents to provide access to the six key forms of institutional support (Stanton-Salazar, 2011).

**Purpose Statement**

The purpose of this study was to examine the effects of generating and utilizing social capital within an informal STEM summer camp as resources to strengthen the academic pipeline for Hispanic students toward careers in STEM. The researcher intended to gain deeper understanding of how learning science in an engaging, non-traditional setting, such as a university campus, could help shape the attitudes of URM students towards science and making STEM choices. Special attention was placed on students’ interpretation of institutional support acquired through interpersonal networks with key institutional agents (teachers, administrators, college students, and professional STEM role models). Social capital provides funds of knowledge, bridging, role modeling, advocacy, emotional and moral support, as well as building a sense of belonging and helps mitigate social inequalities that preserve URM students’ underachievement and lack of participation in STEM fields.

**Research Questions**

1) How can participation in an informal STEM outreach summer camp help shape URM students’ attitudes about STEM?
2) In what ways does an informal STEM outreach summer program affect Hispanic, middle school students’ levels of social capital?

   a) How do participants describe support provided by institutional agents?
   b) How do participants describe support provided by interpersonal networks?
   c) How do participants describe support provided by use of technology?

**Methodological Overview**

To address the research questions, this study employed a qualitative research design, specifically an instrumental case study design using mixed methods within a bounded program. Participants were 7th and 8th grade students from middle schools in San Diego County. Students were strategically selected by their school administrators and science and technology teachers and were invited to apply to a one-week summer science and technology camp.

In order to gather detailed information on participants’ perceptions of the development of social capital, qualitative data were collected from multiple sources: survey, focus group interviews, and electronic documents. The researcher also conducted site observations with adults and peers. These observations were used to understand and confirm comments made by participants. Students were interviewed, using open-ended questions, after attending summer science camp. The researcher conducted three site observations during camp week, each lasting approximately two and a half hours. During the observation periods, the researcher became familiar with the structure of summer camp and was able to observe how students interacted with adults and peers. Participants reflected on their experiences daily by writing an electronic journal entry in “Moodle,” a
virtual learning environment. The transcribed interviews and electronic documents were coded and analyzed using NVIVO. Observations were used to understand and confirm comments made by participants.

Students’ attitudes towards science were measured using an adapted version of the Test of Science Related Attitudes (TOSRA) survey before and after attending summer camp, as well as three months after the camp. Non-parametric statistics, specifically the Mann-Whitney U test for unmatched groups, was used. The intent was to use Mann-Whitney U as an indicator of statistically significant differences between sets of data. T-tests could not be performed because the assessment tool was not normalized.

**Significance of Study**

If our nation plans to meet the demands of the 21st century’s scientific and technical workforce, it is important that research studies examine means to increase the number of Hispanic students leaving K-12 education eligible to pursue STEM-related majors. Research addressing school reform over the last 30 years indicates a need to recognize family and community relationships, not just schooling itself, when trying to explain underachievement (Becerra, 2012; Hill & Torres, 2010; McGraw, 1992). Social capital provides a useful analytic framework for examining the relationships that are needed among families, schools, and communities both during “schooled” and “unschooled” periods of time to encourage participation in STEM fields.

Coleman (1988) saw social capital as a resource for people and explained that individuals enlisted in networks with high levels of social capital mutually benefited from relationships through access to information and other resources in attainment of their
personal interests. Catsambis (1995) adds, “It is possible that factors related to the external environment of family, community and school are more crucial for the achievements and career choices of these students than their attitudes toward science” (p. 252). Current literature lacks information on the development of social capital among minority students in informal academic settings, such as a summer science camp on a university campus. Hence, this study looked at the effects of generating and utilizing social capital through middle school students’ participation in an informal STEM summer camp. This study could help researchers understand participants’ perceptions of how institutional agents and interpersonal networks contribute to the development of social capital, which in turn could translate to academic achievement and STEM choices.

**Definition of Terms**

**Institutional Agent** - persons who use their influence, capacity, and resources relative to their position to assist others in gaining access to networks, resources, information, and opportunities essential for social mobility (Stanton-Salazar, 1997).

**Science, Technology, Engineering, and Mathematics (STEM) Programs** - are non-traditional, out of school educational initiatives directed at increasing students’ science, technology, engineering, and mathematics interest, achievement and influencing STEM related career choices (Oakes, 1990).

**Social Capital** - social relationships from which an individual is potentially able to derive institutional support, particularly support that includes the delivery of knowledge-based resources; for example, guidance for college admission or job advancement (Stanton-Salazar, 1997).
Underrepresented Minority (URM)- are racial and ethnic minorities such as African-American, Alaskan Native, Hispanic American, Native American and Native Pacific Islanders who historically lack representation in STEM fields (NCES, 2007).

**Organization of Study**

Chapter 1 discussed the statement of the problem and rationale for the study, the purpose of the study and research questions, significance of the study, and definition of terms. The remainder of this study consists of four chapters, a bibliography, and appendices. Chapter 2 reviews the literature on Hispanic student achievement, Hispanics in STEM, summer intervention programs, and social capital. Chapter 3 details the methodology of the research study. Included is an explanation of the qualitative design, rationale of sample selection, quantitative and qualitative data collection methods, data analysis, and study limitations. Chapter 4 examines the analysis of data. The summary, conclusions, implications, and recommendations for research are included in Chapter 5. The bibliography and appendices complete the study.
CHAPTER 2: REVIEW OF RELATED LITERATURE

This literature review consists of three sections. It begins with an overview that documents the underrepresentation of Hispanics in Science, Technology, Engineering, and Math (STEM) fields. Then, the challenges faced by Hispanics who pursue STEM careers and a critical analysis of empirical research on intervention programs are presented. Special attention is given to summer programs and informal STEM outreach summer camps. Finally, the concept of social capital is presented. Social capital is the theoretical framework used to guide the study.

Hispanic Underrepresentation in STEM

A well-publicized concern is the fact that minorities and women are highly underrepresented in STEM fields (Howard, K. Calstrom, A., & Solberg, V.S. 2009; Jayaratne, Thomas, & Trautmann, 2003; Morrell, Cotton, Sparks & Spurgas, 2004; NSB, 2006; NSF, 2013; Stake & Mares, 2000; Taningco, Mathew, & Pachon, 2002). In the digital age, developing a technologically literate workforce is essential. Education groups such as the National Science Foundation (NSF) and the National Action Council for Minorities in Engineering (NACME) are calling this underrepresentation “America’s Pressing Challenge” and “The New American Dilemma.” Leading businesses and education groups have teamed up and aimed new initiatives at increasing the number of minorities and women in STEM fields. The Tomas Rivera Policy Institute (TRPI) released a publication addressing the pressing need for Hispanics in STEM professions titled, “STEM Professions: Opportunities and Challenges for Latinos” (TRIP, 2002).
According to data from the U.S. Census Bureau (2010), Hispanics are the fastest growing minority group; they constitute 16% of the nation’s population and are relatively young, at a median age of 27 years as compared to the U.S. median age of 37 years. Between 2000 and 2010, more than half of the United States’ total population increase was due to growth of the Hispanic population. The U.S. Census Bureau 2010 report, released in May of 2011, states, “Between 2000 and 2010, the Hispanic population grew by 43 percent, which was four times the growth in the total population at 10 percent” (p. 2). Additionally, according to the report, in the year 2010, the United States had 50.4 million Hispanics residing here more than doubling the Hispanic population since 1990. At this rate, Hispanics will make up 30% of the nation’s population by the year 2050.

Of special interest is the persistent disparity in the number of Hispanics attracted to careers in STEM fields. According to a report released by the National Science Board (2012), Hispanic representation in science and engineering occupations increased from 3.4% in 1999 to 4.9 percent in 2008, which is proportionally less than their 43% increase in population from 2000 to 2010. It is also significantly lower than Whites, which represent 71.8% in science and engineering occupations. Consequently, some researchers believe that it is important that educational agencies help develop the potential within Hispanic communities to encourage and support professionals in areas that are essential to our nation’s ability to compete in the global market (Howard, Calstrom & Solberg, 2009; Ramsey & Baethe, 2013). Changes in today’s workforce along with the U.S. Bureau of Labor Statistics expectations of job growth in STEM fields of 22% by 2014 (Therrien & Ramirez, 2000) will require that our youth obtain sophisticated skills in these areas. Hector Ruiz, CEO for IBM, states “fostering STEM skills is critically important in
developing an adept workforce to fill the jobs of this expanding digital economy” (2008, p. 2). The lack of math, science and technology skills will negatively impact Hispanics’ chances to compete for employment, wages, and leadership in all professional fields (Oakes, 1990; Ramsey & Beathe, 2013).

The significant increase and youth of the Hispanic population poses a great opportunity to address the gap between the demands for increasing the country’s STEM labor force and the quickest growing population. Given the projected high demands in STEM fields and current initiatives to increase minorities’ participation, Hispanics have unprecedented opportunities to strive for STEM careers. Actualizing the opportunity to bridge this gap requires the comprehension of the STEM pathway for Hispanic students. According to Lyon, Jafri, and St. Louis (2012), building the STEM pipeline begins in early childhood and guides students through K-12, college, post-graduation, culminating with a doctoral degree and a career in a STEM discipline. The underrepresentation of Hispanics in STEM careers has been called the “leaky pipeline” (Jayaratne, Thomas, & Trautmann, 2003) and begins well before formal schooling commences (Villarreal, Cabrera, & Friedrich, 2012). Hence, strengthening the STEM pipeline cannot begin without discussing the egregious disparity in achievement between White and Hispanic students, as well as the more recent education reform efforts to combat the serious achievement gap.

The Early Childhood Education Longitudinal Study, Kindergarten Cohort (ECLS-K) that focused on math and reading achievement is one of many studies that showed the achievement gap is present before children start school (Gandara, 2006; Rock & Stenner, 2005). The study included a nationally representative sample of approximately 23,000
kindergarten students and showed that black and Hispanic students scored half a standard deviation or the equivalent of eight points on an IQ test (with standard deviation of 15) below White students at the beginning of kindergarten in both academic areas. The achievement gap in reading and math presents itself prior to childrens’ entry into kindergarten (Young, Lakin, Courtney, & Martiniello, 2012).

Recent data from the National Assessment of Educational Progress (NAEP, 2013) suggest that a significant difference continues to exist in the number of Hispanic and White students scoring “proficient or advanced” in reading, math, and science. NAEP (2013) data report that there is a 24-point gap in average reading scores between White and Hispanic students by the time they reach eighth grade. In the same study only 22% of eighth grade Hispanic students scored advanced or proficient in reading assessment compared to 46% of White students. At 24-points, the White-Hispanic gap in mathematics remained constant from 2011 (NEAP, 2013). In 2011, the White-Hispanic national gap narrowed in science, but a 29-point gap still exists. These statistics are clear indicators that Hispanic youth are lagging behind their White counterparts and, therefore, are not prepared for higher level, rigorous curriculum in the areas of reading, math, and science. Furthermore, Hispanic school failure, as noted by the persistent White-Hispanic achievement gap, has existed since the 1960s (Gandara, 1995).

No Child Left Behind (NCLB) Reform Policy

Among the most current education reform policies and practices that have attempted to address the achievement gap is the No Child Left Behind Act (NCLB) of 2001. With the passage of NCLB, increasing attention was being paid to the academic achievement of specific subgroup populations of students who historically have not
scored well on standardized tests. NCLB brought to the forefront data providing educators the current evidence that an achievement gap exists between students of color and White students. A large percentage of low-income African American, Latino, and Native American students are at the bottom of the achievement ladder, while a large percentage of middle- and high-income White and Asian students are at the top of the achievement ladder (Johnson, 2002).

With the 2010 national adoption of Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS), it is still unknown what will happen with NCLB. However, it is clear that the 2014 date of having all children at grade level is not going to be met. According to the Washington Post (July 19, 2013), the House of Representatives passed an education bill to reverse NCLB. The bill was passed without any Democratic support and the president has threatened to veto the bill. In response, the Senate Democrats have drafted a separate bill that maintains much of NCLB’s federal oversight policies. One thing is certain, closing the achievement gap continues to be a focus. According to Linda Darling-Hammond, “At a time when children of color comprise a majority in most urban districts, and will be the majority in the nation as a whole by 2025, we face pernicious achievement gaps that fuel inequality, shortchanging our young people and our nation” (2010, p. 20).

Not surprising is the fact that the NGSS focuses on diverse learners. The same four accountability groups defined in the NCLB Act of 2001 are a priority focus, i.e. economically disadvantaged students, English-language learners, racial and ethnic minorities, and students with disabilities. Interestingly, two reasons the NGSS were developed were to address the “leaky K-12 STEM talent pipeline” and to stimulate and
build interest in STEM. The NGSS, completed in April 2013, were developed by the National Research Council in order to provide all students science education for the 21\textsuperscript{st} century. According to the NGSS (2013), stakeholders must understand that the scientific practices in the NGSS include the critical thinking and communication skills that students need for postsecondary success and citizenship in a world fueled by innovation in science and technology. The intentions of the NGSS are to better prepare students for the rigors of college and careers and to prepare a labor force with strong science-based skills.

**Challenges Faced by Hispanics in Pursuing STEM**

The underachievement and under participation of women and minorities in Science, Technology, Engineering, and Math (STEM) has been explored for many decades (Berryman, 1983; Catsambis, 1995; Cole & Espinoza, 2008; Cole & Griffin, 1987; Gandara, 1995; Oakes, 1990; Rendon, 1985; Strawn & Livebrooks, 2012). According to Oakes (1990), students who are able to attain careers in STEM fields, first have to conquer an extensive educational pipeline. For many minority families, navigating the educational pipeline is the primary challenge that diverts their children from STEM experiences (Villarreal, Cabrera, & Friedrich, 2012). The recently released NGSS (2013) also recognizes that minority students’ schooling experiences have a significant impact on their pathways to STEM careers. Factors found to have an impact on underrepresentation of Hispanics in STEM pipeline are academic, cognitive, and socio-cultural (Crisp & Nora, 2006; Young, Lakin, Courtney, & Martiniello, 2012).
Academic Factors

Academic factors refer to the academic preparation and the rigor of coursework that students are exposed to. The academic factors include segregation, prior achievement, opportunities to learn math and science, high school graduation with college level STEM coursework, and institutional choice.

Segregation. An academic factor impacting Hispanic students is tracking, the process of separating students into homogeneous groups based on abilities. Despite the abundance of research asserting that homogeneous grouping does not help any group of students learn better, tracking is still an institutionalized school practice. On the contrary, many studies indicate that tracking negatively impacts average and slow learners (Oakes, 2005). The first sign of Hispanic students’ separation from the scientific pipeline begins in elementary school where they are placed in remedial classes because of a lack of academic achievement (Berryman, 1983; Oakes, 1990; Oakes, 2005). In addition to within-school segregation, known as tracking, Hispanic students are more likely to attend segregated urban schools of lower quality with less-qualified teachers (Young, Lakin, Courtney, & Martiniello, 2012).

Prior achievement. Ramsey and Baethe (2013) write the fundamental causes for failure of potential science graduates are the lack of foundational writing, math, and critical thinking skills, as well as an ethical commitment to persevere in a rigorous major. Furthermore, Cole and Espinoza (2008) found that the high school grade point average of Hispanic students majoring in STEM was an indicator of their overall retention in STEM majors once in college. In their empirical study, Miller, Kimmel, Mier, and Misko (2009) found that the three strongest secondary school predictors of career choices in
STEM are algebra 1 success, mathematics achievement scores, and successfully completing one year of calculus during high school. The researchers analyzed data from the Longitudinal Study of American Youth (LSAY) to provide a clear empirical description of participants’ middle school, high school, college, graduate and/or professional school experiences. This longitudinal study was performed over a period of seven years and funded by the National Science Foundation (NSF). The approximate 6,000 national participants were administered mathematics and science assessments each fall, as well as attitudinal and self-report questionnaires annually, during the fall and spring. This study affirms that algebra 1 success, mathematics achievement scores, and successfully completing one year of calculus during high school are critical for success in STEM fields.

Berryman (1983) found that the STEM talent pool begins to form in elementary school. Moreover, key findings in her study assert that the quantitative pool reaches its maximum size prior to high school. By the time students reach high school the science pipeline flow is mainly flowing outward, as more students choose to or are forced to leave because of poor academic achievement. Hence, she advocates for early intervention, as well as throughout K-12 schooling.

**Opportunities to learn math and science.** Access to a rigorous curriculum and high quality instruction continue to be critical issues for Hispanic students (Gandara, 2006; Oakes, 1990; Taningco, Mathew, & Pachon, 2002; Villarreal, Cabrera, & Friedrich, 2012). Hispanic students are disproportionately incorrectly placed in lower-level mathematics and reading classes (Crisp & Nora, 2006). However, White students are more likely than Hispanics to be placed in “honors” type courses where they are
afforded learning opportunities that prepare them for college prep courses in high school, which lead to interest and success in STEM majors (Catsambis, 1994).

**High school graduation with college level STEM coursework.** According to Young and colleagues (2012) perhaps the failure to complete high school is the most compelling educational barrier faced. Schools that are predominantly minority and low socioeconomic status are less likely to attract or retain high quality math, science, and technology teachers. Minorities continue to diverge from the scientific pipeline during middle and high school years because of their placement in non-college preparatory tracks characterized by low teacher expectations, lacking rigor and cultivation of problem solving and critical thinking skills (Oakes, 1990; Rendon, 1985). Consequently, lower-achieving students enroll in vocational or general education courses that don’t demand higher level mathematics and science knowledge (Berryman, 1983; Oakes, 1990; Oakes, 2005). Thus, Hispanics are disproportionately unprepared for high school and/or college level STEM coursework (Crips & Nora, 2006). The literature revealed the importance of secondary school predictors for STEM choices, as well as the need for school administrators and policy makers to focus on early intervention and ensure minority students a spot on the algebra 1 track.

**Institutional choice.** A key finding in Berryman’s (1983) study was that for Hispanics, the leaks in the STEM pipeline are concentrated at high school graduation and college level. Many scholars have expressed concern regarding the large amount of Hispanic students that enroll in community colleges and less selective universities (Young, Lakin, Courtney, & Martiniello, 2012). According to Young et al. (2012), “Although most Latino students enrolling in community college (85%) express the
intention of receiving a bachelor’s degree, only around 25% of Latino student who initially enroll in community colleges eventually receive a bachelor’s degree” (p. 48). Consequently, the type of institution selected by Hispanics is a factor influencing access to STEM (Crisp & Nora, 2006).

**Cognitive Factors**

Cognitive factors refer to those “non-academic” or “social/emotional” factors. The cognitive factors are attitudes, beliefs, and perceptions toward STEM and self-efficacy. Last, socio-cultural factors include socioeconomic status (SES), parent involvement and language barrier, social experiences, and mentoring encounters.

**Attitudes, beliefs, and perceptions toward STEM.** Although, many studies have been conducted on specific group differences in cognitive abilities and attitudes, no findings have established significant effects on achievement or choices to pursue STEM (Oakes, 1990). Numerous studies have explored gender differences and the influence of affective factors on the achievement and participation of women in STEM, but few focus specifically on Hispanic students (Berryman, 1983; Crisp & Nora, 2012; Jayaratne, Thomas & Trautman, 2001; Morrell, Cotton, Sparks & Spurgas, 2004; Oakes, 1990; Stake & Mares, 2000; Weinburg, 1995). In previous research, blacks displayed higher positive attitudes than other groups, yet they hold the lowest achievement levels. Studies in which non-Asian minorities are lumped together found that liking math or science does not lead to high achievement or participation by minority students cite this. These findings question the hypothesis that positive attitudes cause higher levels of achievement and participation. Furthermore, Ramsey and Baethe (2013) assert that “interest alone was not the deciding factor for student success in science classes” (p. 26).
Some studies suggest that the unequal participation of females and minorities in quantitative fields has to do with a greater interest in “people” and being less attracted to “things” (Oakes, 1990). School mathematics, science, and technology are commonly taught as abstract topics and disconnected from people, negatively impacting students’ interest (Haynes, 2008; Oakes, 1990). More recent research asserts that students who find personal meaning and relevance in STEM learning experiences will pursue STEM beyond school requirements (Lyon, Jafri, & St. Louis, 2012).

**Self-efficacy.** Psychologist Albert Bandura’s definition of self-efficacy refers to a person’s belief in their ability to succeed in certain situations. A person’s sense of self-efficacy plays a critical role on how to approach challenges and goals. Someone with strong self-efficacy will not shy away from a challenge. On the contrary, the belief in their successful performance will lead to mastery of task. Even when Hispanic students demonstrate an interest in science careers, they often find it difficult to visualize themselves as a professional in a science career, such as research scientist or engineer (Crisp & Nora, 2006). Fast, Lewis, Bryant, Bocian, Cardullo, Reddig, and Hammond (2010) substantiate that higher levels of math efficacy was a positive predictor of performance in mathematics. This study of over 1,100 upper elementary students, of which 62% where Hispanic, examined the effect of students’ math self-efficacy on standardized testing in mathematics. These researchers conclude, “students who perceived their classroom environment as more caring, challenging, and mastery-oriented had significantly higher levels of math efficacy, and higher levels of math efficacy positively predicted math performance” (2010, p. 739).
Socio-Cultural Factors

Socio-cultural factors refer to those involving both social and cultural factors. The socio-cultural factors include socioeconomic status (SES), parent involvement and language barrier, social experiences, and mentoring encounters.

Socioeconomic status (SES). Family socioeconomic status, determined by parental education level, is a major factor in non-Asian minorities’ straying from the quantitative pipeline (Berryman, 1983). Berry’s landmark research established that being a second generation college student served as an equalizer in increasing the probability of pursuing a quantitative major for non-Asian minorities and White students (Berryman, 1983). Economically disadvantaged minorities generally attend inner city or rural schools characterized by less federal and state funding; fewer qualified teachers; less math, science, and technology resources; and less rigor (Oakes, 1990). Unfortunately, families living in poverty often cannot afford to provide their children access to supplemental or informal learning opportunities in math and science. Mobility, resulting from families’ low SES, disrupts learning; this also negatively affects academic achievement.

Parent involvement and language barrier. Despite the research findings that family support and engagement are critical to perseverance in STEM aspirations, many Hispanic families lack the knowledge, dispositions, and skills to navigate the school system (Crisp & Nora, 2006). For many parents, the language barrier alone inhibits them from acquiring the information about educational options and opportunities that will benefit their children. Catsambis (1994) recognized the importance of having a family
support system in forming and promoting minority students’ interest in science and math careers.

**Social experiences.** For many Hispanic youth, cultural patterns and academic goals may be in conflict (Gandara, 1995; Vela, 2003). School success, or “acting White,” is a stereotype description that African American and Hispanic students often develop. Students fear alienating their friends and adopt an oppositional culture, resisting the academic challenges of school (Gandara, 1995). Alongside this stereotype some minorities might also experience the “big fish in a small pond” conflict. Many minority students from disadvantaged backgrounds may be viewed as academically outstanding, but they have not experienced the level of rigor offered in advanced placement classes. Once they enter college they are often overwhelmed, the “culture shock” leading them to drop out of the science pipeline.

**Mentoring encounters.** In a unique study focusing on Hispanic students’ success rather than failure, Gandara (1995) utilized a follow-back, retrospective method to gather data from fifty high-achieving Hispanics. The fifty participants were from low-income Mexican-American homes in the barrio; yet they managed to obtain degrees (Ph.D., M.D., J.D.) from highly-respected American universities. In their interviews, participants shared their insights as to how they overcame pervasive challenges similar to those described in this section. Although all participants were exemplary students, the majority emphasize that the “minority recruitment programs” they encountered were the key to their college academic success.

The literature revealed that Hispanic youth need early intervention and extra support systems in order to achieve and persevere in STEM fields. Gandara (2006)
states, “Thus, the most powerful intervention to strengthen the pipeline would be to eliminate initial achievement gaps” (p. 224). Early intervention is one of the important keys to helping these students achieve. Given the findings of these researchers, it is important to explore the literature base on out-of-school time (OST) programs, including minority STEM outreach programs, in attempts to narrow the achievement gap.

**STEM Outreach Summer Programs**

The underrepresentation of minorities in STEM has given rise to a focus on interventions in out-of-school time (OST) and settings such as local businesses, universities, recreational parks, museums, science research centers, and community organizations (Bell, Lewenstein, Shouse & Feder, 2009). In 1988 the U.S. Congress published a report acknowledging the need for informal education and intervention programs in order to enhance STEM pipeline in our country:

> The out-of-school environment offers opportunities to enhance students’ appreciation of science and mathematics or to give them “second chances” in these areas, regardless of test-determined abilities. Programs outside of school can be both alternatives and complements to school activities. (Educating Scientist and Engineers: Grade School to Grad School, p. 36)

In the past decade, the federal No Child Left Behind Act of 2001 also established strong accountability requirements for schools to implement out-of-school time programs in efforts to close the achievement gap (Lauer et al., 2006; Kim & Quinn, 2013). Therefore, it is important to begin discussions about summer learning loss and its impact on the “leaky pipeline” affecting underrepresentation of Hispanics in STEM careers.
**Summer Learning Loss**

Summer school was implemented by many school districts in the early 20th century, long before the passage of the No Child Left Behind Act of 2001. However, the purpose of summer school has drastically changed. Cooper, Charlton, Valentine, Muhlenbruck, and Borman (2000) shared the history behind the creation of summer school:

The passage of the first child labor law in 1916 meant that school-aged children had little, if anything, to do during their vacation from school. Community leaders demanded that organized recreational activities be made available for students when school was out. Education officials responded by creating the first summer programs. (p. 1)

Cooper, et al. (2000) explained that the current pressures to address the achievement gap gave rise to the existent purpose of summer schooling: “Throughout this century, the purposes of summer schools have expanded from the initial goal of preventing delinquency to include remediation and prevention of learning deficiencies, flexible scheduling, academic enrichment and acceleration, summer employment for teachers, and mitigation of summer learning loss” (p. 7). Moreover, the accountability attached to higher academic standards brought on by high stakes testing supports the need for high quality summer intervention programs.

In addition, changes in the American family structure have created a demand for school-based programs that call for quality educational and recreational programs when school is not in session. The typical family icon of the 1950s that included an employed father, a homemaker wife, and two children rarely exists. It has been replaced with families in which both heads of household work or those headed by a single parent.
In the past 15 years, three meta-analyses of summer programs have been conducted. In the first meta-analysis and narrative review “Making the Most of Summer School,” the authors synthesize and integrate the findings of 93 evaluations of summer school (Cooper, Charlton, Valentine, & Muhlenbruck, 2000). The second meta-analysis, “Out-Of-School Time Programs: A Meta-Analysis of Effects for At-Risk Students,” examined and analyzed 35 OST studies (Lauer, Akiba, Wilkerson, Apthorp, Snow, & Martin-Glen, 2006). Findings of the previous two meta-analytic reviews suggest that the effects of summer school depend on the quality of programs and evaluation design. Hence, the updated meta-analysis “The Effects of Summer Reading on Low-Income Children’s Literacy Achievement From Kindergarten to Grade 8: A Meta-Analysis of Classroom and Home Interventions,” synthesized 41 classroom and home-based summer reading programs. A common finding for all three reviews was that OST programs, such as summer school, had positive effects on student achievement.

Cooper, Charlton, Valentine, and Muhlenbruck (2000) drew five principal conclusions from their synthesis of the research. First, programs that focus on decreasing and/or eliminating learning deficits show improvements on the knowledge and skills of students. Second, both programs focusing on acceleration of learning and remediation have similar positive impact on participants. Third, middle-class students experienced more growth than students from disadvantaged backgrounds. Fourth, remedial summer programs are more effective when the program is run in a small community, having smaller numbers of schools and classes. Last, summer programs are more effective when they provide small group or individual instruction.
In the meta-analysis presented by Cooper et al. (2000), many programs they reviewed focused on the socioeconomic status of participants and the subject of “summer setback-learning loss.” The studies addressed remediation and social promotion programs. The disciplined inquiry of studies was quantitative in nature. Primary sources of data were pre- and post-test scores, data on background characteristics of participants, and surveys. Results were interpreted in terms of standards of deviation and effect sizes. Overall, results of studies reviewed in the meta-analysis generalized that the participation in summer intervention programs had a positive effect on students’ achievement. However, the level of achievement varies based on the characteristics of the student and program. These studies provide an important look at positive effects summer programs have on academic achievement.

Lauer et al. (2006) found that OST programs positively impacted the achievement of at-risk students in areas of reading and mathematics. Larger positive effect sizes were found in programs that contained specific characteristics such as tutoring in reading. Interestingly, this analysis found that it did not make a difference on effectiveness whether the OST program took place after school or in the summer. This meta-analysis reviewed research on OST programs from 1985-2003. The thirty-five OST studies analyzed employed more rigorous research methods defined by the use of control or comparison groups.

The most recent meta-analysis review conducted by Kim and Quinn (2013) supports previous findings that summer intervention has positive effects on reading outcomes. Contrary to findings by Cooper et al (2000), this study found that the mean effect size was statistically significant and positive within studies where the majority of
the children were low-income. Hence, summer interventions implementing research-based reading instruction had significantly larger effects for students with low-income backgrounds. This synthesis reviewed 41 classroom and home-based summer reading interventions from 1998-2011.

Although most programs are reactionary and were created with the purpose of providing students assistance only after they were already academically behind, the Teach Baltimore Summer Academy was created with hopes of mitigating summer learning losses before students have a chance to fall behind. Thus, the Teach Baltimore Summer Academy is a proactive and preventative program aimed at intervening early. The program was offered to kindergarten students and utilized volunteers to provide students small group instruction. Borman et al. (2004) conducted an empirical study of this program over a three-year period. The study was quantitative in nature, randomly selecting students and placing them in a treatment or control group. The results of the three cohorts studied showed no initial benefit after the first year of summer school, and one cohort actually experienced achievement loss after the first year. It wasn’t until the third year that each of the three cohorts’ treatment effects showed growth of statistical significance. Findings supported the theory that summer learning losses by children in poverty may be compounded over time.

The mandatory summer intervention program called Summer Bridge put in place by Chicago Public Schools (CPS) in 1996-97 addressed social promotion. Students in grades three, six, and eight who did not meet the benchmark score on the Iowa Tests of Basic Skills were required to attend Summer Bridge. However, this became a problem for CPS because by the year 2000 one-third of the students in these benchmark grades
failed to meet requirements, and 97% of these students were minorities, specifically African-American or Latino. A team of researchers at the Consortium on Chicago School Research gathered data in order to analyze the effectiveness of Summer Bridge on student achievement. They found that the program was effective in increasing test scores (specifically among 6th and 8th graders), program gains were similar across demographic and achievement groups, and students had a positive outlook about their summer program experience. The program was more effective when teachers knew their students beforehand. Also, the program kept students from falling further behind, and quality interactions between teachers and students were found to have a positive effect on program effectiveness.

Alexander, Entwisle and Olson (2001) address the effects of race, gender, and socioeconomic status on students’ learning during both the “schooled” and “unschooled” periods of time. “Unschooled” refers to the long summer break in which students are not attending school but are in their homes and communities. The authors find that lower socioeconomic status (SES) students start school already behind, make growth during the “schooled” periods, and experience achievement losses during the summer. Alexander et al. (2001) assert, “Lower SES youth start out behind (i.e., the baseline differences are significant) and during the school year they keep up, but during the summer periods their gains fall short of those registered by upper SES youth” (p. 182). Achievement losses were found in both reading and math and were specific to socioeconomic level. Sex and race/ethnicity findings were not fully significant in affecting student achievement. Alexander et al. (2001) conclude the following:
These details of the seasonal pattern of disparities in achievement in reading and math all accord with the descriptive pattern seen earlier, but they are specific to family socioeconomic level: none of the summer adjustment coefficients for sex or race/ethnicity is fully significant under either specification. (p. 182)

![Figure 2.1: Summer Learning Loss Increases the Achievement Gap (Alexander, Entwisle, & Olsen, 2004)](image)

More disappointing findings than those revealing socio-economic-based learning differences is that summer learning losses of poor children may be compounded over the elementary school years (Alexander, Entwisle, & Olsen, 2004; McCombs, Augustine, & Schwartz, 2011). These cumulative differential learning rates contribute to the pervasive growth of the achievement gap (See Figure 2.1).

Alexander and colleagues (2001) present the “faucet theory” as an explanation for the achievement gap. In short, the “faucet theory” refers to when students are in session, the faucet is on and all students benefit from school resources and equally make
academic growth during this time. Although, the school resource “faucet” is turned off for all students when school is not in session. During the summer, parents of middle-class students are able to make-up for the school’s resources to a certain extent. Unfortunately, families of low-socio economic status are often not capable of doing the same. Summer time is a critical time for intervening and providing economically disadvantaged youth opportunities and resources their families cannot afford.

Recently, Gershenson (2013) focused on understanding the possible reasons for the differential rates of summer learning loss between students of different socioeconomic backgrounds. The researcher analyzed the amount of time students spent on activities associated with cognitive development and the amount of time parents spent interacting with students, which he referred to as “summer time-use gap.” Data collected from two time-diary surveys, the Activity Pattern Survey of California Children and the American Time Use Study, were analyzed. The most notable summer time-use gap finding was that students of low socioeconomic backgrounds watch television two hours more per day than their wealthier peers. The study also found a statistically significant summer time-use gap of 12 minutes in the area of adult-student conversation. This suggests that some students of low-income backgrounds spend more time in front of television, instead of conversing with parents in the summer time. While the last statistically significant finding was much smaller, it helps explain the importance of parent involvement during summer. The American Time Use Study data suggest that parents of higher-income children spend more time physically caring for their children and organizing stimulating activities, which in turn positively impact cognitive development.
Solving the summer learning loss problem is complex and can be costly. Research identifying “summer setback-learning loss” in students of lower socioeconomic status has caused educators to take a closer look at the current purpose, structure, and effectiveness of summer intervention programs. Kim and White (2011) pose an alternative approach that may be less expensive, yet equally effective. After analyzing results of five studies that simply provided students books to read in the summer, researchers proposed two simple elements to cost-effective summer reading programs. First, students must be provided books that match their interests and reading levels. Another important element is sufficient parent-child interactions (Gershenson, 2013). More specifically, teacher and parents scaffolding that supports effective comprehension, and fluency practices are necessary (Slates, Alexander, Entwisle, & Olsen, 2012).

Summer school studies have shown that schools do matter and that the achievement gap between lower SES and higher SES increases during the “unschooled” periods. Heyns (1987) affirms this idea in noting, “The answer from summer learning is straight forward. Schools promote learning relative to fixed periods of time without schooling; schools also equalize outcomes-not absolutely, but relative to the inequality produced when schools are closed” (p. 1153). Moreover, Roderick, et al. (2003) contributed by reminding educators that summer intervention programs are not a substitute for year-round effective instruction.

**STEM Outreach Summer Programs**

A review of the literature revealed the diversity within STEM outreach summer programs. Programs differed in populations they served, length of intervention, purpose, data collection methods, cost effectiveness, funding sources, and area of STEM they
addressed. Many STEM summer intervention programs have focused mainly on girls, with minimal attention to race/ethnicity, specifically Hispanic middle school students. Additionally, many STEM outreach programs focused on college students. It was difficult to condense data on science intervention programs due to their diversity; however, all programs were alike in their efforts to strengthen the STEM pipeline.

Although, all the programs had a focus on STEM, they varied in their purpose. Some programs focused on the development of science literacy and skills. Other programs focused on sparking motivation and building confidence. Still others engaged students in real life scientific experiences and attempted to combat dominant culture stereotypes. Programs also varied in the age groups they targeted, ranging from elementary age groups to university students. However, the majority of the programs chose to intervene at points in which girls and minority students may be most vulnerable for abandoning the science pipeline (Jayaratne, et. al, 2001; Wiebe, Faber, Corn, Collins, Unfried, & Townsend, 2013).

Programs designed to intentionally foster socio-emotional skills as students were immersed in high-caliber STEM activities positively impacted minorities’ interest in STEM (Chi, Snow, Goldstein, Lee, & Chung, 2010; Rajashankar, Tahernezhadi, & Vohra, nd; Yilmaz, Garcia, Guillen, & Ramirez, 2011). Examples of socio-emotional skills are communication, self-confidence, self-efficacy, teamwork, cooperation, and leadership. According to Lyon, Jafri, and St. Louis (2012), some design elements of programs that support students who are least likely to engage in STEM opportunities include the following:
• Equity- science is made accessible to underrepresented minorities, specifically students of color, girls, socio-economically disadvantaged youth, and students who struggle academically or socially.

• Relationships- long-term relationships among peers, scientists, mentors, and staff from middle school through college are emphasized.

• Access to experts- content is taught by passionate STEM professionals and students build social capital through relationships with science experts.

• Meaningful work- project-based learning in the service of youth development is the focus, not meeting academic or workforce outcomes.

Project Exploration, a non-profit education organization based in Chicago, has been working to change the face of science. The organization is committed to making science accessible to minorities through a program design focused on social and emotional development. Results from a 10-year retrospective study of the effects of Project Exploration programs revealed the following:

• 95% of project participants graduated or were on track to graduate from high school,

• 60% of project participants who enrolled in four-year college pursued STEM degrees,

• 60% of project participants graduated from college with a STEM degree (Chi et al., 2010).

Chi and colleagues (2010) shared qualitative findings, “Meaningful work with scientists and long-term relationships with caring adults were critical factors in students’ decisions to persist in Project Exploration and in STEM” (p. 50).
The recent Northern Illinois University Enhancing Engineering Pathways program (NIU-EIP) conducted in 2009 focused on establishing a sustainable pathway for middle and high school female students to the field of engineering. Rajashankar, Tahernejadhi, and Vohra, (2009) concluded that “The initial most significant program success were the increased degree of awareness and increased self-efficacy that were achieved through the series of workshops that provided opportunities for various hands-on activities, interaction with a broad spectrum of female engineering role models, lectures and video demonstrations . . .” (p. 5). Results of the pre-post survey design revealed that 70% of middle school and 75% of high school participants strongly agreed or agreed that their self-efficacy and awareness in the field of engineering increased. Seventy percent of middle school girls and 100% of high school girls strongly agreed or agreed that teamwork was important in helping them network with their peers and gain comprehension of engineering projects. High school and undergraduate mentors were utilized to help overcome inhibitions about making new friends among middle school students. The use of hands-on activities made it fun to work with new peers, which eventually built friendships as they worked in teams.

Stake and Mares (2000) evaluated two intervention programs focused on enhancing science confidence and motivation of gifted high school students. Participants were male and female gifted high school students from a large metropolitan area in the Midwest. The two programs evaluated were intensive full-time summer enrichment programs that took place on a university campus, Program 1 (4-weeks) and Program 2 (6-weeks). The only difference between both programs was that Program 2 included a research proposal assignment. The intervention program integrated effective science
education components such as active, inquiry-based learning; individual mentoring; female and male science role models; and information about a wide variety of science-related careers.

Data were collected at three points via multiple measures such as questionnaires, attitude scales, and quick writes, measuring science attitudes, goals, and science advantages. Questionnaires were completed pre-program, post-program, and six months after program completion. The purpose of the third administration was to measure the “splashdown effect.” Stake and Mares (2001) define the splashdown effect as, “program-related changes the program graduates recognize in themselves that became apparent to them after reentry to their home high school” (p. 359). At the post-program point, students also wrote a brief description of any changes they had noted in themselves as a result of participation.

The multiple measures design of this study showed strong evidence of program success. Students who benefitted most from program participation were girls, those with supportive families and teachers, and those who already possessed greater confidence in their abilities upon entrance into program. However, there were no significant changes in attitude between the pre- and post-tests.

A literature review of STEM outreach programs reveals a need for more studies that focus on Hispanic middle school students’ pursuit of STEM choices. It is clear from the research that Hispanic students begin to divert from the science pipeline as early as elementary school because of their lack of academic achievement (Cole & Espinoza, 2008, Ramsey & Baethe, 2013). Furthermore, Oakes (1990, 2005) recommends the use of additional out-of-school resources in order to increase the achievement of girls and
minorities by providing additional, positive science and mathematics experiences both in and out of school, as well as differentiated instruction and career information. Oakes also asserts that programs exposing women and minorities to role models have a positive impact on their choice to pursue a science major. Given minority students’ lack of opportunities and resources, social capital is the lens utilized to inform this study. STEM outreach programs that capitalize on relationships with scientists and institutional partnerships will ensure that students build the social capital needed to strengthen the science pipeline (Lyon, Jafri, & St. Louis, 2012).

**Theoretical Framework: Social Capital**

Research addressing school reform over the last 30 years indicates a need to recognize family and community relationships to the school, not just schools themselves, when trying to explain underachievement (McGraw, 1992). Social Capital provides a useful analytic framework for examining the relationships that are needed among families, schools, and communities during both “schooled” and “unschooled” periods of time. The central figures in the development of the social capital concept and its theoretical framework are French sociologist Pierre Bourdieu and American sociologist James Coleman. Therefore, the work of these two sociologists provide a social capital framework to find a solution for persistent educational and social problems (Dika & Singh, 2002).

Bourdieu articulated his conceptualization of social capital by distinguishing among the three forms of capital: economical capital, cultural capital, and social capital. “Social capital is the aggregate of the actual or potential resources which are linked to
possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” (Bourdieu, 1983, p. 249). He emphasized the benefits of membership, which can be material or symbolic. In short, social capital symbolizes the relationships that allow people access to assets possessed by members of a network or group and the amount and quality of resources (Portes, 1998). Consequently, having social connections increases individuals’ access to knowledge, cultural capital, and economic resources (Jarrett, Sullivan, & Watkins 2005; Stanton-Salazar, 2011).

Coleman’s (1988) conceptualization focuses on the role of social capital in the family and in the community in the creation of human capital. He saw social capital as a resource for people and explained that individuals enlisted in networks with high levels of social capital mutually benefitted from relationships through access to information and other resources in attainment of their personal interests. Additionally, he built on the economic principle of rational action, in which he said that social capital was a resource that each actor had control over or interest in. Coleman (1988) defines social capital by its function stating, “It is not a single entity but a variety of different entities, with two elements in common: they all consists of some aspect of social structures, and they facilitate certain actions of actors -whether persons or corporate actors-within the structure” (p. 98).

Social capital is intangible, existing in relationships between people. In this intangible form, social capital refers to: (1) obligations, expectations, and trustworthiness of structures, (2) information channels, and (3) norms and effective sanctions. The first form of social capital is highly dependent on trustworthiness of the social environment. The second form is the potential information that can be acquired in social relations. Last,
norms and effective sanctions can constitute a powerful form of social capital because it can facilitate desired actions and stifle others. Coleman speaks to the existence of intergenerational closure as a social structure promoting the creation of effective norms. He gives example of parents knowing the parents of their children’s friends and explains that closure builds trustworthiness in social structures.

Social capital, as used in this study, is founded on Stanton-Salazar and Dornbusch’s (1995) definition: “social relationships from which an individual is potentially able to derive institutional support, particularly support that includes the delivery of knowledge-based resources; for example, guidance for college admission or job advancement” (p. 119). Stanton-Salazar (1997) describes institutional support in terms of six key forms as follows:

1) Provision of various funds of knowledge (i.e., institutional sanctioned discourse, academic task-specific knowledge, organizational/bureaucratic knowledge, network development, technical, knowledge of labor and educational markets, and problem solving); 2) bridging, or the process of acting as a human bridge to gatekeepers, to social networks and to opportunities for exploring various “mainstream” institutions (i.e., university campuses); 3) advocacy and related forms of personalized intervention; 4) role modeling; 5) provision for emotional and moral support; 6) provision of regular, personalized, and soundly based evaluative feedback, advice, and guidance (p. 11)

Since institutional agents are typically well positioned to empower students with key forms of social and institutional support, students of low-status depend on institutional agents to provide access to the six key forms of institutional support (Stanton-Salazar, 2011).
Family Social Capital

Similar to Bourdieu, Coleman stresses the importance of social networks, but Coleman’s interpretation stresses the importance on child socialization: “the norms, the social networks, and the relationships between adults and children that are of value to the child’s growing up” (Coleman, 1987, p. 36). The resources that children bring from home are loosely characterized by Coleman as attitudes, effort, and conception of self. Parcel and Dufur (2001) share in this view, stating, “We focus on family social capital, which refers here to the bonds between parents and children that are useful in promoting child socialization” (p. 882). Additionally, many researchers believe that social capital also reflects the quality of relationships between adult and child, including the time and effort expended on interactions with children, monitoring their activities, promoting well-being, and educational achievement (Coleman, 1988; McGraw, 1992; Parcel & Dufur, 2001; Stanton-Salazar, 2011).

In attempts to understand child development and educational achievement, researchers turn to families as the primary source of social capital for children, especially in relation to education. Although, many have made attempts to measure family social capital, there is no universal agreement or tool to measure the degree or quality of social capital held by families. Coleman (1988) was the first to attempt this in his study of high school drop out rates and degree of social capital. In his “High School and Beyond” study the variables he used to measure social capital were parents’ presence, additional children in family, family size, and mother’s expectation for the child’s education.

In later studies, additional indicators of social capital were studied.. Runyan, et al., (1998) also measured social support to primary maternal caregiver, neighborhood
support, and church or religious services attendance by maternal caregiver. Findings were that the presence of each social capital indicator increased the likelihood of doing well. Additionally, the addition of any one indicator increased the chances of doing well by 29% and adding any two increased chances by 66%. Crosnoe (2004) measured family social capital by using the indicators of parent-adolescent emotional distance, parent-adolescent relations in school, and student teacher bonding. His findings are of extreme importance in the development of the concept of family social capital because he found that achievement at school was associated with the emotional tone of students’ relationship with their parents, which supports that family social capital is important for achievement (Slater, Alexander, Entwisle, & Olsen, 2012). Measures of family social capital used by Israel, Beaulieu, and Hartless (2001) were focused on interactions relevant to education, included nurturing activities and monitoring efforts. Similar to Crosnoe, they found that social capital in the family promoted a child’s educational achievement.

**School-Based Social Capital**

Social capital correlated with schools refers to bonds between parents and schools that can promote educational outcomes, as well as the relationships that parents and children form with school teachers (Parcel & Dufur 2001; Dufur, Parcel, & Troutman 2013). Students spend large amounts of time in school where they interact with educators and are exposed to school-like resources that Coleman (1987) characterized as opportunities, demands, and rewards. Schools do more than provide academic information; they also organize students’ social environments. These social environments reflect social ties that enhance learning. A study by Goddard (2003)
confirmed the importance of the presence of social capital at school. He found “when teachers-student and teacher-parent relationships are characterized by trust and schools characterized by academically supportive norms, social relations have the potential to help students achieve academic success” (p. 10).

Findings of multiple social capital studies support the importance of school-based social capital and school engagement/student achievement, especially for students at risk of school failure or of socioeconomically disadvantaged backgrounds (Brewster & Bowen, 2004; Croninger & Lee, 2001; Crosnoe, 2004; Slater, Alexandar, Entwisle, & Olsen, 2012; Stanton-Salazar, 2011). Brewster and Bowen (2004) explored the correlation between teacher support and school engagement of high school students at risk of school failure. They defined teacher support in terms of the degree to which teachers listen, encourage, and respect students. Four measures were selected to explore the relationship between teacher support and school engagement: problem behavior, perception of school meaningfulness, parental support, and teacher support. Results confirmed that teacher support is important in Latino students’ school engagement. Croninger and Lee (2001) also explored the correlation between teacher support/guidance and dropping out of high school. They measured social capital in terms of student-teacher relations and student-teacher talks outside the classroom. Results supported that all students benefit from teacher-based forms of social capital, but at-risk students benefit most.

Community Based Social Capital

Coleman (1988) pointed out that social capital also occurs outside the family within networks made up of adults in the community. Coleman explained that social
capital can be found outside the family structure in the community via relationships among parents and among relations with the institutions of the community. Common findings of multiple studies were that social capital both at home and outside of it, in the surrounding adult community, was positively correlated with promoting children’s educational engagement and achievement. (Brewster & Bowen, 2004; Coleman, 1987, 1988; Israel, Beaulieu, & Hartless, 2001; Slater, Alexander, Entwisle, & Olsen, 2012; Stanton-Salazar, 2011).

The formation of personal relationships is important in the development and socialization of adolescents, particularly the relationships between youth and adults in the larger community. Jarrett, Sullivan, and Watkins (2005) examined the relation between organized youth programs and the development of relationships with adults in community, which in turn provide adolescents with social capital. In studying three community-based programs, researchers found that youth acquired social capital in the form of information, assistance, exposure to adult worlds, and encouragement. They also found that the formation of social capital was process-oriented, meaning it took time for youth to develop comfort, trust, and meaningful connections with adults. Further, these findings are in alignment with Putnam’s (1995) theory of social capital in which he articulated “the more we connect with other people, the more we trust them, and vice versa” (p. 665).

**Social Capital and STEM**

A gap in the research literature exists in the area of social capital and STEM. Given that Hispanic youth are least likely to pursue STEM choices, some researchers believe it is critical that STEM opportunities be relationship based, not just workforce
driven. For example, one of the core design elements of the successful Chicago-based project called Project Exploration was to build social capital through creating relationships between students and passionate STEM professionals (Lyon, Jafri, & St. Louis, 2012). The program’s STEM learning experiences are strategically designed to support students’ social and emotional development. Hence, the program intentionally structures relationships among students, staff, and scientists. According to Chi, Goldstein, Lee, and Chung (2010), “Meaningful work with scientist and long-term relationships with caring adults were critical factors in students’ decisions to persist in Project Exploration and in STEM” (p. 50). Additionally, the Next Generation Science Standards call for the utilization and development of social capital in order to ensure access to all students, including non-dominant student groups.

**Summary**

Hispanic underrepresentation in STEM fields is a growing concern, especially given statistics demonstrating that Hispanics are the fastest growing population. For many minority families, simply navigating the educational pipeline is the first and foremost challenge that diverts them from a STEM pathway. Hispanics face academic, cognitive, and socio-cultural factors that impact their underrepresentation in STEM fields. Furthermore, research uncovers the grim results of summer learning loss as it affects both students of disadvantaged backgrounds and minority students. Additionally, findings by Borman, et al. (2004) confirms that the effect of summer learning loss is compounded over time for these students of disadvantaged backgrounds.
Research on social capital provides more positive results. Overall, most studies addressing issues of social capital in connection to student achievement confirmed that social capital is positively correlated with students’ engagement and achievement. Most studies emphasized that for students who lack social capital at home, it was crucial that schools and communities generate it in order to provide opportunities to enhance learning. Likewise, social capital is crucial for families with fewer financial and educational resources (Runyan, et al., 1998) because it allows them to keep the resource faucet flowing during the summer months.

There are many studies that focus on STEM attitudes, motivation, and confidence, but few are specific to Hispanics. Additionally, few studies are qualitative in nature, lacking an in-depth study of students’ perceptions of the development of social capital as a result of participating in STEM outreach programs. Hence, there is a need for this study that thoroughly unpacks students’ experiences and investigates how out-of-school time opportunities can strengthen the Hispanic pipeline into STEM fields.
CHAPTER 3: METHODS

This chapter lays out the methodology for the study. It consists of seven sections: research design, population and sample, instrumentation, data collection procedures, data analysis, positionality, and limitations. First, the chapter discusses the purpose of the study and research questions. The instrumental case study design using mixed methods within a bounded program is presented. The sampling and selection criteria for the school sites and students are also presented in this chapter. Description of instruments is explained, with supporting documents included in appendices. Data collection methods and analysis are presented. Last, the chapter closes with a statement of the researcher’s positionality and limitations of the study.

Research Design

The purpose of this study was to examine the effects of generating and utilizing social capital within an informal science, technology, engineering, and math (STEM) summer camp as resources in strengthening the academic pipeline for Hispanic students toward careers in STEM. The researcher intended to gain deeper understanding of how children learning science in an engaging, non-traditional setting, such as a university campus, could help shape the attitudes of underrepresented minority URM students towards science and making STEM choices. Special attention was placed on students’ interpretation of institutional support acquired through interpersonal networks with key institutional agents (teachers, administrators, college students, and professional STEM role models). Social capital provides funds of knowledge, bridging, role modeling, advocacy, emotional and moral support, as well as building a sense of belonging. It helps
mitigate social inequalities that maintain URM students’ underachievement and lack of participation in STEM fields.

**Research Questions**

1) How can participation in an informal STEM outreach summer camp help shape URM students’ attitudes about STEM?

2) In what ways does an informal STEM outreach summer program affect Hispanic, middle school students’ levels of social capital?
   a) How do participants describe support provided by institutional agents?
   b) How do participants describe support provided by interpersonal networks?
   c) How do participants describe support provided by the use of technology?

**Methodology**

This study employed a qualitative research design, specifically an instrumental case study design using mixed methods within a bounded program. According to Yin (2009), “A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context” (p. 18). The phenomena of the study were the student participants engaged in a STEM outreach summer camp. Additionally, Creswell (1998) defines qualitative research as an approach allowing the researcher to explore a bounded system by collecting precise, in-depth data from multiple sources. An instrumental case study design allowed the researcher to conduct an in-depth examination of the attitudes and perceptions of a group of Hispanic middle school students before and after their participation in a STEM outreach summer camp. The case study approach also allowed the researcher to investigate ways in which institutional agents, interpersonal networks, and the use of technology helped Hispanic students
develop social capital which, in turn, positively impact attitudes and perseverance in STEM.

The bounded program was a week-long STEM outreach summer camp called Investigations for Quality Understanding and Engagement for Students and Teachers (iQUEST) held at California State University San Marcos in July, 2010. The iQUEST program was funded by the National Science Foundation, sponsored by California State University San Marcos, and provided at no cost to participants. Participants selected were underrepresented minority (URM) students who had interest and potential in science and technology. Participants were engaged in hands-on, interactive, innovative science and technology activities. They gained valuable university campus experiences and interacted with college students, scientists, professionals, and university faculty, all of whom served as mentors. The ultimate goal of the iQUEST summer camp was to promote interest in STEM careers and strengthen participants’ ability to excel in science and technology during the upcoming school year.

According to Yin (2009), incorporating evidence from multiple sources increases the quality of a study significantly. Since each data collection has its deficiency, it is essential to gather data from multiple sources in order to increase accuracy and credibility of findings (Creswell, 2005; Yin, 2009). Triangulation of different types of data and methods of data collection allows the researcher to address problems of construct and validity by providing varied measures of the phenomenon (Creswell, 2005; Yin, 2009). In order to ensure that findings from this study were authentic and trustworthy, different sources of data and methods of data collection were triangulated. Data were collected from multiple sources: survey, focus group interviews, and electronic documents. The
A triangulation mixed methods design (Creswell, 2005) allowed the researcher to (1) give equal priority to both quantitative and qualitative data, (2) collect both quantitative and qualitative data simultaneously, and (3) compare results from quantitative and qualitative analyses to determine if the two databases yield similar or dissimilar results. In a triangulation mixed methods design the researcher is able to benefit from the strengths of each method: generalizability from quantitative data and in-depth understanding of context or setting from qualitative data. Furthermore, qualitative data strengthened the study by giving participants an opportunity to voice their experiences verbally and in writing.

**Population and Sample**

Crewswell (2005) states that in non-probability sampling the researcher selects participants who are conveniently available and represent characteristics the researcher plans to study. Selected schools and students were chosen according to the Investigations for Quality Understanding and Engagement for Students and Teachers (iQUEST) project design. A convenience sampling method was appropriate because students willingly applied to participate in the program and were available to be studied. The researcher gained participation consent from parents (Appendix E).
Participating Students

The study sample consisted of 49 Hispanic, middle school students. Participants were 7th and 8th grader students from five middle schools in San Diego County. The 7th grade sample consisted of 12 male and 14 female students. The 8th grade sample consisted of 11 male and 12 female students. See Table 3.1.

Table 3.1 Participant Demographics

<table>
<thead>
<tr>
<th></th>
<th>Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100% Hispanic</td>
</tr>
<tr>
<td></td>
<td>7th Grade</td>
</tr>
<tr>
<td>Schools</td>
<td>5</td>
</tr>
<tr>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td>Female</td>
<td>14</td>
</tr>
</tbody>
</table>

The participants were pre-selected by science teachers, technology teachers, and administrators at each school. Pre-selection was based on participants being URM students who had interest and potential in science and technology. Students also had to have good grades in citizenship and parent approval. The pre-selected students were then invited to apply for iQUEST summer camp. Participants who met the following criteria were considered for admission to the summer camp:

- Completeness and timely submission of application (Appendix C)
- Evidence of interest per “personal statement” section of application
- Grades in math, science, and technology of “C” or better
- Socio-economic disadvantaged background
- Participation in academic programs such as AVID or honors classes
- Teacher recommendation (Appendix D)
- Parent/guardian permission

Using these criteria, fifty participants were selected to attend the July 2010 iQUEST summer camp. However, one student moved away after being selected and did not attend. Therefore, the total participants who attended the week-long summer camp was forty-nine. The researcher contacted each participant and respective parents/guardians via telephone, acquired verbal consent for participation, and scheduled a meeting in which the purpose of the research was explained. At this meeting, written consent (see Appendix E) for participation in the study was obtained.

**Participating Sites**

The San Diego County middle school sites were purposefully selected for this study based on their demographics and proximity to the university campus. Each partner school served a large number of minority students. Four of the five schools were within 15 miles of the summer camp location. The administrator of the school that was located approximately 35 miles away from summer camp location made transportation arrangements for the students. Table 3.2 describes each school.
<table>
<thead>
<tr>
<th>School</th>
<th>Size</th>
<th>Demographics</th>
<th>Social Class Status</th>
<th>Proximity to CSUSM</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harriet Tubman</td>
<td>265</td>
<td>African-American 33% Asian 6% Caucasian 11% Filipino 2% Hispanic 46%</td>
<td>Low to Middle</td>
<td>35 Miles</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Filipino 2% Hispanic 46% Native Hawaiian/Pacific Islander 3% Two or more Races 1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Madison</td>
<td>1,480</td>
<td>African-American 5% Asian 4% Caucasian 49% Filipino 2% Hispanic 36%</td>
<td>Middle</td>
<td>8 Miles</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>American Indian or Alaska Native 1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vista Magnet</td>
<td>200</td>
<td>African-American 2% Asian 1% Caucasian 34% Filipino 2% Hispanic 57%</td>
<td>Low to Middle</td>
<td>8 Miles</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pacific Islander 2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MLK</td>
<td>1434</td>
<td>African-American 9% American Indian 1% Asian 4% Caucasian 33% Filipino 6%</td>
<td>Middle</td>
<td>14 Miles</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hispanic 44% Native Hawaiian/Pacific Islander 3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Elijo</td>
<td>1263</td>
<td>African-American 4% American Indian 1% Asian 6% Caucasian 62% Filipino 4%</td>
<td>Middle to Upper</td>
<td>3 Miles</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hispanic 21% Native Hawaiian/Pacific Islander 1%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Instrumentation

The instruments used in the study to answer the research questions included: (a) focus group interviews, (b) electronic documents, and (c) adapted Test of Science Related Attitudes (TOSRA). In addition, the researcher also conducted site observations to become familiar with structure of camp and observe student interactions with adults and peers. These observations were used to understand and confirm comments made by participants. The alignment of the research questions and the methodology used in the study are outlined in Table 3.5.

Focus Group Interviews

According to Yin (2009), the interview provides the case study the most important sources of information. Open-ended interviews incorporating friendly, non-threatening questions allow participants to thoroughly communicate their experiences (Creswell, 2005; Yin, 2009). The purpose of focus group interviews was to gain an in-depth understanding of students’ perceptions of knowledge/information gained, support from institutional agents, use of technology, enhancement of interpersonal networks, and attitudes about STEM. The interview questionnaire was modeled after a previously used questionnaire in a qualitative study exploring African-American students’ perceptions of social capital development as a result of their participation in a STEM pre-college program (Fuller, 2008). The seven open-ended questions were modified to reflect participation in iQUEST summer camp, instead of a STEM Pre-College Program. Additionally, questions were added that are specific to the use of technology during the summer camp (see Appendix B for Interview Questionnaire).
Electronic Documents

According to Creswell (2005), public and private records are considered documents for analysis in qualitative studies that provide information to help researchers understand key phenomena. During an initial activity the first day of camp, students quickly learned two things: what scientists do and that reflection is part of learning. Students wrote and posted daily reflections in electronic journals via “Moodle.” Moodle is a virtual learning environment that educators use to develop online communities of learning. Blog entries in “Moodle” are password protected and visible to camp participants and staff only. Blog entries included daily reflections and a final reflection on the last day about their weeklong experiences. Ticklers were provided to prompt participants’ reflections. For instance:

- What did I learn today in camp?
- What was one of the “ah-ha!” moments for you?
- What was it that I enjoyed the most about the activities?
- What computer technology made it possible for you to collect, store, process, and/or share information today?
- How are talents in arts, communication, math, and/or sciences critical to great computer using experience?

Participants also had the option of adding photographs and videos to their journal entries. The purpose of collecting electronic documents was to gain an in-depth understanding of students’ perceptions of knowledge/information gained, support from institutional agents, use of technology, enhancement of interpersonal networks, and attitudes about STEM.
Observations

Site observations were also used to inform this study. The STEM outreach summer camp took place at a university campus in multiple settings such as university classrooms and conference rooms, computer and science laboratories, and outdoor spaces. These natural settings were ideal opportunities for direct observation (Yin, 2009). For the researcher, as a participant observer, the purpose of site observations was to become familiar with structure of camp and observe student interactions with adults and peers. These observations were used to understand and confirm comments made by participants. Given the structure of small group activities and the use of technology devices, the researcher had to be in close proximity to students and circulating often in order to observe participants’ comments and engagement. Creswell (2005) defines a participant observer as “an observational role adopted by researchers when they take part in the setting they observe. As a participant, you assume the role of an “inside” observer who actually engages in activities at the study site” (p. 212).

Survey

This study employed a longitudinal survey design. Creswell (2005) describes longitudinal survey design as “the survey procedure of collecting data about trends with the same population, changes in a cohort group or subpopulation, or changes in a panel of the same individuals over time” (p. 357). The quantitative element that was used to inform this study was an adapted version of the Test of Science Related Attitudes (TOSRA) survey (Appendix A).

The TOSRA survey used in this study was an adapted version of the original TOSRA created by Barry J. Fraser at Macquarie University, Sydney, Australia in 1978 to
measure student interests and attitudes about science. The TOSRA was initially used with 7th-10th graders in Australia and it is frequently used with middle and high school students in the U.S. (Hussar et al., 2008). It has proven validity and reliability scores of Cronbach’s alpa: 0.82, test-retest: 0.78, and cross-cultural validity has been established in the U.S. (Hussar et al., 2008). Fraser’s original TOSRA is a 70-item Likert scale, which measures seven constructs. Table 3.3 describes the seven constructs.

Table 3.3: Subscales, Descriptions and Example Items

<table>
<thead>
<tr>
<th>SUBSCALE</th>
<th>DESCRIPTION</th>
<th>EXAMPLE ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Social Implications of Science</td>
<td>The extent to which a student believes science impacts society in a positive or negative way</td>
<td>Scientific discoveries are doing more harm than good.</td>
</tr>
<tr>
<td>2. Normality of Scientists</td>
<td>The extent to which a student believes scientists are considered normal human beings</td>
<td>If you met a scientist, he would probably look like anyone else you might meet.</td>
</tr>
<tr>
<td>3. Attitude toward scientific inquiry</td>
<td>The extent to which a student adopts scientific inquiry</td>
<td>It is better to ask the teacher the answer than to find it out by doing experiments.</td>
</tr>
<tr>
<td>4. Adoption of scientific attitudes</td>
<td>The extent to which a student adopts general scientific attitudes</td>
<td>I am curious about the world in which we live.</td>
</tr>
<tr>
<td>5. Enjoyment of science lessons</td>
<td>The extent to which a student enjoys participating in science lessons</td>
<td>Science lessons are fun.</td>
</tr>
<tr>
<td>6. Leisure interest in science</td>
<td>The extent to which a student is interested in science as a leisure activity</td>
<td>I would like to be given a science book or a piece of scientific equipment as a present</td>
</tr>
<tr>
<td>7. Career interest in science</td>
<td>The extent to which a student is interested in science as a career</td>
<td>When I leave school, I would like to work with people who make discoveries in science</td>
</tr>
</tbody>
</table>

(Hayden et al., 2009)
Although the TOSRA survey was considered a valid and reliable assessment instrument, it had not been utilized with populations having demographic characteristics similar to those included in study. Therefore, the need arose for the re-validation of TOSRA. During the Spring of 2009, approximately 991 students from various San Diego, Orange, and Riverside county schools took the survey. Table 3.4 shows detail about the students who participated in the re-validation. A Rasch model analysis was performed. The results of the re-validation were a shortened version of the TOSRA survey consisting of 28 items scored on a five-point Likert scale measuring one construct--attitude toward science.

Table 3.4: Participant Demographics for Re-validation of TOSRA

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>52.4%</th>
<th>Female</th>
<th>47.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>African American</td>
<td>5.9%</td>
<td>American Indian</td>
<td>1.7%</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>3.8%</td>
<td>Filipino</td>
<td>4.2%</td>
</tr>
<tr>
<td></td>
<td>Hispanic/Latino</td>
<td>54.9%</td>
<td>Pacific Islander</td>
<td>0.9%</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>28.5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Grade Level | 6 | 27.8% | 7 | 21.9% | 8 | 12.3% | 9 | 14.7% | 10 | 3.1% | 11 | 13.3% | 12 | 6.8% |

(Hayden et al., 2009)

All participants took the adapted version of the TOSRA survey (Appendix A) using www.Surveymonkey.com on the first (Time 1) and last day (Time 2) of the week long summer camp, as well as three months after (Time 3). In order to give participants
an opportunity to reflect and thoroughly evaluate how they might have changed as a result of the summer program, a third administration of the survey was given three months after program completion. Stakes and Mares (2003) describe the purpose of the third administration as the *splashdown effect*: “delayed recognition of program impact on science attitudes after reentry to the home high school” (p. 361).

**Data Collection Procedures**

The collection of data started in July 2010 at California State University San Marcos. The entire data collection was completed by October of 2010, at which time the researcher visited partner schools to administer the TOSRA survey to the summer camp participants for the third time. The researcher was granted personal release time for the October 2010 school visits, since the researcher was a full-time charter school Principal/CEO. All research documents were kept in a locked file cabinet at the researcher’s home and data files were kept in the researcher’s laptop to be accessed only with a secured password.

The two focus group interviews were conducted on the last day of summer camp. Six Hispanic students were randomly selected for each focus group interview, three boys and three girls. The same interview questionnaire and procedure was followed each time. Each focus group interview began with researcher explaining to participants the purpose of the interviews and the procedure. Participants were also informed that there were no right or wrong answers, that the activity was not a test, and that their responses would be kept private and confidential. Each student was given an opportunity to respond to each question. Although it only occurred once, students were allowed to pass if they did not
have a response. Students were also able to ask clarifying questions. On occasion, the researcher had to repeat questions to the group because students wanted clarification or they simply had forgotten question. Interviews were conducted in designated university classrooms to honor participant confidentiality, lasted approximately 25-30 minutes, tape-recorded, and transcribed.

The second data source collected was the participants’ daily electronic journal entries via the “Moodle” environment. At the end of each day, students were escorted into a computer laboratory for their daily reflections. Each student logged on to the iQUEST 2010 Summer Camp “Moodle” site and entered login information. Once logged in, students typed their daily reflection, which consisted of comments, photographs, and/or videos. Students typically posted comments and photographs of their favorite activities, pictures with their new friends and staff, and new technology tools. On the last day of camp, students were provided extra time to type final reflections summarizing their entire summer camp experience. The researcher obtained digital copies of daily entries for all students and created files for each day.

The researcher conducted three site observations during camp week in order to understand camp structure and observe students’ interactions with peers and adults. Each site observation lasted approximately two and one-half hours. The activities that researcher observed were shore crab observation, geocaching involving GPS devices, journaling in Moodle on-line environment, taking apart a consumable camera, microscopy activity, and lunch time.

The adapted TOSRA survey was administered to the 49 students who attended iQUEST summer camp. It took the students approximately 20-30 minutes to complete
survey. Students were escorted to a designated computer lab at CSUSM where they took survey using www.Surveymonkey.com on the first and last day of the week-long camp. For the third administration, the researcher visited students at their respective home school and made arrangements with school administrators to have students take TOSRA survey by accessing iQUEST website. Administrators at home schools were supportive in assisting the researcher with logistics of having students take the survey during lunch time to ensure that instructional time was not impacted. The survey was administered in a library or computer laboratory of each school. Each student had been assigned a confidential identification number, which they used each time the survey was taken. Results of the survey from first day of camp (Time 1), last day (Time 2) and three months after (Time 3) were reviewed for trends and to reinforce anecdotal data obtained from interviews, electronic documents, and observations.

**Data Analysis**

The process of data analysis involves “making sense out of text and data…and preparing the data for analysis, conducting different analyses, moving deeper and deeper into understanding the data, representing the data, and making an interpretation of the larger meaning of the data” (Creswell, 2009, p. 183). The researcher looked for patterns and themes in the data through analysis of the focus group interviews and daily reflections, coding of the data, and further analysis as themes and patterns emerged. The researcher’s goal was to describe the views of the students as reflected in the focus groups and digital reflections. Common themes were identified across the data (focus
group interviews and five days of students’ individual reflections) with regard to each research question.

The first level of identification occurred during the initial review of the interview transcripts and digital reflections. These two sources of data were combined in the analysis process because together the transcripts and digital reflections captured the student voices in verbal and written form. The researcher read each transcript and reflection. In the next step, the researcher conducted open coding utilizing NVivo 9 software, is an analytic tool to facilitate the coding process. The researcher used open coding, which incorporates a brainstorming technique described by Corbin and Strauss (2008) to “open up the data to all potentials and possibilities contained within them” (p. 160). The next step was pattern matching techniques and data reduction through frequency counts that helped researcher identify the themes mentioned most often. The data were then recoded and a codebook was organized using these dominant themes. The researcher used observations to confirm comments made by participants in interviews and reflections.

Students’ attitudes towards science were measured using an adapted version of the Test of Science Related Attitudes (TOSRA) survey before and after attending summer camp, as well as three months after. Although the initial study proposal called for descriptive statistics and t-tests to analyze survey responses and to see if there was a significant difference in attitudes before and after attending the summer camp, this was not done because the assessment tool was not normalized. Therefore, non-parametric statistics, specifically the Mann-Whitney U test for unmatched groups, was used (Siegel, 1956). The intent was to use Mann-Whitney U as an indicator of statistically significant
difference between sets of data. Time 1 refers to the initial time the TOSRA survey is taken on the first day of camp, Time 2 refers to the survey taken on last day of camp, and Time 3 refers to the survey taken three months after Time 2 to account for splash-down effect. Since the adapted TOSRA survey contained ten of Fraser’s negatively worded statements to reduce response bias, these items were reverse coded for analysis (Pallant, 2005).

The following table (3.5) demonstrates the alignment of each research question and the methodology used in study. The table outlines the research questions, data source, and method of analysis. The multiple data sources, such as focus group interviews, digital reflections, survey, and observations were triangulated to corroborate results. Triangulation is the process in which to confirm the findings “by showing that independent measures of it agree with it or at least, do not contradict it” (Miles & Huberman, 1994, p. 266).
Table 3.5: Alignment of Data Sources and Research Questions

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Source</th>
<th>Method of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) How can participation in an informal STEM outreach summer camp help shape Underrepresented Minority (URM) students’ attitudes about STEM?</td>
<td>Adapted TOSRA Survey</td>
<td>Mann-Whitney U Test</td>
</tr>
<tr>
<td></td>
<td>Focus Group Interviews</td>
<td>Coding &amp; Reduction, Pattern Matching, Content Analysis</td>
</tr>
<tr>
<td></td>
<td>Electronic Documents</td>
<td></td>
</tr>
<tr>
<td>2) In what ways do informal STEM outreach summer programs affect Hispanic, middle school students’ levels of social capital?</td>
<td>Focus Group Interviews</td>
<td>Coding &amp; Reduction, Pattern Matching, Content Analysis</td>
</tr>
<tr>
<td></td>
<td>Electronic Documents</td>
<td></td>
</tr>
<tr>
<td>a) How do participants describe support provided by institutional agents?</td>
<td>Focus Group Interviews</td>
<td>Coding &amp; Reduction, Pattern Matching, Content Analysis</td>
</tr>
<tr>
<td></td>
<td>Electronic Documents</td>
<td></td>
</tr>
<tr>
<td>b) How do participants describe support provided by interpersonal networks?</td>
<td>Focus Group Interviews</td>
<td>Coding &amp; Reduction, Pattern Matching, Content Analysis</td>
</tr>
<tr>
<td></td>
<td>Electronic Documents</td>
<td></td>
</tr>
<tr>
<td>c) How do participants describe support provided by use of technology?</td>
<td>Focus Group Interviews</td>
<td>Coding &amp; Reduction, Pattern Matching, Content Analysis</td>
</tr>
<tr>
<td></td>
<td>Electronic Documents</td>
<td></td>
</tr>
</tbody>
</table>

**Positionality**

The researcher’s experience as a parent and administrator motivated her to investigate Hispanic students’ pathways to STEM careers. This study arises, partially, from my experience as a parent of an intelligent Hispanic male who decided to vacate the science pipeline after his first year of attendance at a university. Additionally, I am an administrator of an elementary school that is 50% Hispanic. Given my naturally
optimistic nature and passion for strengthening the Hispanic science pipeline, I feared that I might hold a potentially-biased mindset expecting summer camp to render positive results. I was also concerned that students’ behaviors and/or responses may have been biased by my presence. Given my disciplinary role for students enrolled at my school, I did not interview these students. I solicited the assistance of a peer who interviewed the students enrolled at my school. However, I did interview students from the other school sites. Since I speak Spanish and I am a Hispanic female, most students spoke comfortably about their experiences and challenges in pursuing STEM. Given my son’s experiences, I was aware that there are many forces that shape a child’s decision to pursue science. I listened attentively and objectively documented students’ responses because it is important to my study that we understand these forces.

**Limitations**

One limitation of the study is that it included a small number of Hispanic students who were initially selected based on their pre-stated interest in science and other specified criteria. The participants in the study did not reflect the characteristics of all Hispanic students and, therefore, the study may not be generalizable beyond this group or setting. Another limitation is the short time frame of the one-week camp, especially given the mixed results of previous studies of such programs, which show no significant effects. Additionally, the limited time frame of the pre-post design may not capture adequately the long-term effects of the program.
Summary of Methods

This chapter discussed the methodological aspects of a qualitative research design, specifically an instrumental case study design using mixed methods within a bounded program. The study documented participants’ attitudes towards science and making STEM choices, as well as participants’ perceptions of how institutional agents, interpersonal networks, and use of technology promoted their development of social capital. Data collection consisted of the administration of multiple measures that included survey, focus group interviews, electronic documents, and observations. Qualitative data consisting of focus group interviews and electronic documents were analyzed using NVivo 9 software. Quantitative data consisting of pre- and post-surveys were analyzed using non-parametric statistics and utilizing the Mann-Whitney U test for unmatched groups. The different data sources were triangulated to strengthen results of findings. Chapter 4 presents a discussion of the results of the study. Finally, Chapter 5 will present findings, implications, and recommendations for action and further research.
CHAPTER 4: RESULTS

Prior chapters in this dissertation discussed the purpose of the study, along with a comprehensive literature review supporting the need for more research in the area of social capital and Science, Technology, Engineering, and Math (STEM), defined the theoretical framework that influenced the study, and outlined the methodology and research questions. The purpose of this study was to examine the effects of generating and utilizing social capital within an informal STEM summer camp as resources in strengthening the academic pipeline for Hispanic students toward careers in STEM. This chapter is organized into two sections. The first section describes and summarizes the qualitative data findings. The second section describes a summary of quantitative data findings.

The researcher’s objective was to identify factors relevant to two research questions. Research Question 1 was “How can participation in an informal STEM outreach summer camp help shape Underrepresented Minority (URM) students’ attitudes about STEM?” Research Question 2 asked “In what ways does an informal STEM outreach summer program affect Hispanic, middle school students’ levels of social capital?” Specifically, the study wished to discover the following:

(a) How do participants describe support provided by institutional agents?
(b) How do participants describe support provided by interpersonal networks?
(c) How do participants describe support provided by use of technology?

The study sample consisted of 49 Hispanic, middle school students. Participants were 7th and 8th grade students from five middle schools in San Diego County who participated in the Quality Understanding and Engagement for Students and Teachers
(iQUEST) Summer Camp during summer 2010. The 7th grade sample consisted of 12 male and 14 female students. The 8th grade sample consisted of 11 male and 12 female students. Selected schools and students were chosen according to the Investigations for iQUEST project design. The participants were pre-selected by science teachers, technology teachers, and administrators at each school. Pre-selection was based on participants being URM students who had interest and potential in science and technology. Students also had to have good grades in citizenship and parent approval. The pre-selected students were then invited to apply for iQUEST summer camp.

**Summary of Qualitative Data Analysis**

The process of data analysis involves “making sense out of text and data…and preparing the data for analysis, conducting different analyses, moving deeper and deeper into understanding the data, representing the data, and making an interpretation of the larger meaning of the data” (Creswell, 2009, p. 183). The researcher looked for patterns and themes in the data through analysis of the interviews, coding of the data, and further analysis as patterns and themes emerged. The researcher’s goal was to describe the views of the students as reflected in the focus group discussions and digital reflections. Common themes were identified across three data sources with regard to each research question. The three data sources analyzed included two sets of focus group interview transcripts and one set of digital reflections. The digital reflections included five days of the 49 participants’ individual reflections.

The first level of identification occurred during the initial review of the interview transcripts and digital reflections. The researcher read each interview transcript and
student reflection, and then conducted open coding utilizing NVIVO 9 software, an analytic tool to facilitate the coding process.

The researcher used open coding, which utilizes a brainstorming technique described by Corbin and Strauss (2008) to “open up the data to all potentials and possibilities contained within them” (p. 160). In open coding, the researcher thoroughly reviewed the data contained within the data set before beginning to group and label concepts. The process of coding extracted the raw data and pulled out concepts and then further developed data in terms of patterns, grouping them into themes. The data analysis process included the following steps:

1. Review all interview transcripts and digital reflections
2. Import the data into NVIVO
3. Code the data in NVIVO using open coding
4. Define the properties of the dominant themes
5. Create categories that represent themes and subthemes
6. Recode the data using the identified themes and subthemes

The coding process identified a set of themes for each research question. The first group of themes addressed how an informal STEM outreach summer camp helped shape URM students’ attitudes about STEM. The second group of themes focused on the ways an informal STEM outreach summer program affected Hispanic, middle school students’ levels of social capital. The resulting themes are described in the summary of the results.

VALIDITY, TRUSTWORTHINESS, AND RELIABILITY

The researcher ensured the validity, trustworthiness, and reliability of the research study through employing various mechanisms. Qualitative validity, according to Creswell
(2009), means that the researcher checks for the accuracy of the findings by employing certain procedures. Validation of findings in qualitative research occurs throughout the steps in the process of the research (Creswell, 2009). The researcher did a continual check during the coding process to ensure that coding did not drift from the original intent as the coding process unfolded. An electronic codebook within NVivo was used to code the data. There was no need to cross check for inter-coder agreement because only one researcher was responsible for analyzing the data.

**Summary of the Results for Research Question 1**

Research Question 1 focused on how participation in an informal STEM outreach summer camp helped shape URM students’ attitudes about STEM. This section describes the five primary themes related to Research Question 1 that emerged through coding analyses using NVIVO, and includes tables summarizing the definition of the identified themes and the overall frequency of occurrence for the themes and subthemes. As reflected in Table 4.1, the primary themes were “make learning fun,” “hands-on learning,” “learn new STEM content,” “increased interest in STEM-related careers,” and “increased confidence in STEM learning.” Table 4.2 shows the frequency with which the themes and subthemes appeared across focus group interviews and student reflections.
Table 4.1: Themes and Definitions for Research Question 1: Attitudes About STEM

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make learning fun</td>
<td>Making learning fun and exciting helped shape STEM outreach summer camp participants’ attitudes about STEM</td>
</tr>
<tr>
<td>Hands-on learning</td>
<td>Hands-on learning helped shape STEM outreach summer camp participants’ attitudes about STEM</td>
</tr>
<tr>
<td>Learn new STEM content</td>
<td>Learning new STEM content helped shape STEM outreach summer camp participants’ attitudes about STEM</td>
</tr>
<tr>
<td>Increased interest in STEM-related careers</td>
<td>Participation in the STEM outreach summer camp increased students’ interest in STEM-related careers</td>
</tr>
<tr>
<td>Increased confidence in STEM learning</td>
<td>Participation in the STEM outreach summer camp increased students’ confidence in STEM learning</td>
</tr>
</tbody>
</table>

Table 4.2: Frequency of Themes for Research Question 1: Attitudes About STEM

<table>
<thead>
<tr>
<th>Theme</th>
<th>Number of sources</th>
<th>Total exemplar quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make learning fun</td>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>Hands-on learning</td>
<td>1</td>
<td>41</td>
</tr>
<tr>
<td>Learn new STEM content</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Increased interest in STEM-related careers</td>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>Increased confidence in STEM learning</td>
<td>3</td>
<td>21</td>
</tr>
</tbody>
</table>

**Make learning fun.** Research Question 1 focused on how participation in an informal STEM outreach summer camp helped shape URM students’ attitudes about STEM. The first theme that emerged through analyses was *make learning fun*, which refers to making learning fun. This theme was mentioned 52 times across the focus groups and digital reflections. Examples of this theme follow.

A student from the focus group said, “I enjoyed the geocaching because, I met new
people and it was fun because it was like adventurous.” Another student stated, “I enjoy the eye dissection because I've never done a dissection before and it was fun and disgusting at the same time.” One student explained:

I think that the crab was fun because I got to work with the partner and I met like new people during the activity. I didn’t know how to work with a live crab ever before, it was my first time and it was really interesting.

In a reflection another student wrote, “The most exciting part was when we observed the crabs, it was very fun because the when held the crabs they would start moving one time it even fell on the table.” Still another student wrote, “Looking back at our day, I think that it was a very exciting, fun, and interesting day, and I'm so glad I got to participate in this years iQuest camp.” In a final example, a student wrote:

A few of the others were fun like, when you see light your brain can translate it to the color. We also had a teleconference with Dr. Joe Pow and learned what cameras are for. That was a fun day!!!

**Hands-on learning.** The next theme for Research Question 1 that emerged through coding analyses was *hands-on learning*, which refers to hands-on learning shaping STEM outreach summer camp participants’ attitudes about STEM. This theme was mentioned 41 times in the digital reflections.

Participants provided examples of the hands-on learning experienced at camp. One student wrote, “What I enjoyed the most about the activities was that we got to learn about both computers and science. For example the hands on crab lab that was a really great experience.” Another student wrote, “The thing that I enjoyed most was the ability to do a hands on experiment and with that I could personally learn and actually remember what I did.” In a third example, a student reflected:
We got to interact, hold, and observe real, live crabs. I really enjoyed being able to get a hands-on experience, which you don’t come across often. The part mentioned above, was my favorite part of today (even though a crab pinched me once).

**Learn new STEM content.** Through coding of digital content, the theme *Learn new STEM content* was mentioned 30 times across the focus groups and digital reflections. This theme was defined as learning new STEM content helped shape STEM outreach summer camp participants’ attitudes about STEM. One focus group participant mentioned learning new things, “Yes because we learned new things, and if we do it again, we'll know step by step how to do it, and because we can help others if they don't know what we learn here.” Another student said:

I learned a lot about crabs and how ... Now I could know if it's female or a male by their stomach. I also learn a lot about the eyes, like new names I didn’t know, like the iris. I really like learning about the eye.

In one of the reflections, a student wrote:

Today I learned about the pachygrapsus crassipes, also known as: the Striped Shore crab. I learned how to identify the gender of a male and a female. When it had my crab, it was a female, yet I called her Hermit. When I learned about the crabs is also that their kingdom name is Crustnea. I also learned how to identify a pregnant and non-pregnant female. I, unfortunately... did not get a pregnant female. I also learned that the striped shore crab has 6 walking legs, 2 chelipeds, an abdomen, and 2 swimming legs. We also learned how to handle the crabs, we learned the parts of the crab, the kingdoms, its real name(s).

In a final example, a student wrote, “You learned how to talk to communicate with one another online, and you learn new things everyday by using technology in many different ways.”

**Increased Interest in STEM-Related Careers.** *Increased interest in STEM-related careers* was the fourth most frequently mentioned theme that emerged through
coding analyses for Research Question 1. It was mentioned 28 times across the focus groups and digital reflections. This subtheme refers to the perception that participation in the STEM outreach summer camp increased students’ interest in STEM-related careers. This theme is exemplified in the following interview exchange:

Student 2: I think I would because Science is very exciting and interesting.
Speaker 1: Okay, and is that something that you decided before or after attending the camp?
Student 2: Attending the camp.

Another student said, “I think I will consider getting a job in science particularly as a doctor because I really enjoy like dissecting like we had with the cow's eye. I had already thought that before, but this camping encouraged me more.” Another student explained, “I think I would consider a job like a Scientist because there's many ways. Because I thought there's only like you have to research stuff and all that. But there's Science involved in everything.” In a final example, a student reflected:

Okay so I thought that the cow eye was really an interesting thing because it was a great way to experience. For me I want to be a surgeon and I think it will help me a lot to know how to do things step by step and then something with an animal because an animal can be related to a human but in different parts.

**Increased Confidence in STEM Learning.** Increased confidence in *STEM learning* was the least mentioned theme for Research Question 1. Increased confidence in STEM learning was mentioned 21 times across the data. This theme refers to the perception that participation in the STEM outreach summer camp increased students’ confidence in STEM learning. This theme can be seen in the following examples. In the focus group interviews, a student stated the following:
Speaker 1: Do you feel the summer camp activities have made you feel that you can be more successful in science and technology than before you came to the camp?

Student 1: Yes because, if I do it again I would know how to do it.

One student simply stated, “it made me feel confident now and we learned lots of stuff.”

Another student said he/she was now less afraid of STEM:

Student 5: Yes, because I got more interested in science than I did before. Now I feel, like I more capable of doing the job.

Speaker 1: Would you say it's less scary to you?

Student 5: Yeah.

Another said, “When I did all the activities, it made me feel that I like science more.”

One student reflected, “I am extremely happy and proud of myself that I can now say that it have held a crab and maybe I got a bit freaked out in the beginning but I did it.” In a final example, a student reflected, “I’m so happy I’m going to take what I learned and put my effort on it in 7th grade, I think I’m going to know everything we do.”

Summary of the Results for Research Question 2

Research Question 2 was “In what ways does an informal STEM outreach summer program affect Hispanic, middle school students’ levels of social capital?” Three sub-research questions were examined:

(a) How do participants describe support provided by institutional agents?

(b) How do participants describe support provided by interpersonal networks?

(c) How do participants describe support provided by use of technology?
This section includes tables summarizing the definition of the identified themes for each sub-research question and the overall frequency of occurrence of the themes.

**Support provided by institutional agents.** As reflected in Table 4.3, the two themes that were identified through analyses for Sub-research Question A (How do participants describe support provided by institutional agents?) were “helpful teachers and staff” and “staff made learning exciting.” Table 4.4 shows the frequency with which the themes appeared across the focus groups and digital reflections.

Table 4.3: Themes and Definitions for Research Question 2: Support Provided by Institutional Agents

<table>
<thead>
<tr>
<th>Theme/Subtheme</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helpful teachers and staff</td>
<td>STEM outreach summer camp teachers and staff were helpful</td>
</tr>
<tr>
<td>Staff made learning exciting</td>
<td>STEM outreach summer camp staff made learning exciting and interesting</td>
</tr>
</tbody>
</table>

Table 4.4: Frequency of Themes for Research Question 2: Support Provided by Institutional Agents

<table>
<thead>
<tr>
<th>Theme/Subtheme</th>
<th>Number of sources</th>
<th>Total exemplar quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helpful teachers and staff</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Staff made learning exciting</td>
<td>3</td>
<td>11</td>
</tr>
</tbody>
</table>

**Helpful teachers and staff.** “Helpful teachers and staff” was the most frequently mentioned theme for Sub-research Question A. This theme was mentioned 24 times across the focus groups and digital reflections and was defined as students perceiving that STEM outreach summer camp teachers and staff were helpful. In the focus group, one student said, “If sometimes if I would have questions about what we
were working out, I would ask the teachers and they would kindly explain it to me.”

Another focus group participant said, “I think that all the teachers helped me, because many of them told me that don't let other people tell you what you can be.” A third student stated, “They [teachers] helped me when I didn't know how to use the camera the ones that you have.” Still another student mentioned:

Okay I thought the teachers were most helpful to me because like when we were doing the GPS, we didn’t … my group didn’t really know how to use it and so our teacher or the group leader he helped us how to use to use it and then we finally knew how to use it so I think that the teacher was most helpful.

In a final example, a student reflected, “I would like to thank all the teachers for everything their doing and for the things their teaching me!”

*Staff made learning exciting.* Comments related to the theme “Staff made learning exciting” was identified 11 times across the focus groups and digital reflections. It refers to students’ perceptions that STEM outreach summer camp staff made learning exciting and interesting. In the focus group, a student explained:

Well same as Leslie, like I said I mean what helped me most is that like the assistants and the teachers that were working with us were like really great because Mr. O’Neill, he didn’t make the subjects boring, he like had some comedy with it but also is that during the time when on Skype to talk to college students. George, Sam and Samuel were explaining how like they got bored; it was the first subjects but how the teachers made it interesting and that’s the way I feel all the teachers and assistants made it fun for us, that’s all I’m saying.

Another focus group participant said:

I also liked that Mr. O’Neill explained how a laser would refract and reflect in a glass block. In addition I mostly liked when we were talking to Dr. Joe Pow [scientist] about how to make a spark in a camera.

In a reflection, one student wrote:
What I liked about today was that we went Geocaching. Geocaching is when you use a GPS to find secretive boxes or other so like things. Lastly it was a great time Geocaching with Mr. O’neil [summer camp instructor].

**Support provided by interpersonal networks.** As reflected in Table 4.5, two themes were identified for Sub-research Question B (How do participants describe support provided by interpersonal networks?). As reflected in Table 4.5, the two primary themes were *teamwork and collaborations* and *developed relationships*. Table 4.6 shows the frequency with which the themes appeared across the focus groups and digital reflections.

Table 4.5: Themes and Definitions for Research Question 2: Support Provided by Interpersonal Networks

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork and collaborations</td>
<td>Teamwork and collaboration supported students’ STEM learning</td>
</tr>
<tr>
<td>Developed relationships</td>
<td>Students developed friendships and built relationships, which supported students’ STEM learning</td>
</tr>
</tbody>
</table>

Table 4.6: Frequency of Themes for Research Question 2: Support Provided by Interpersonal Networks

<table>
<thead>
<tr>
<th>Theme</th>
<th>Number of sources</th>
<th>Total exemplar quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork and collaborations</td>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td>Developed relationships</td>
<td>3</td>
<td>41</td>
</tr>
</tbody>
</table>

**Teamwork and collaborations.** Provide real world business experience was the most frequently mentioned theme for Sub-research Question B. This theme was mentioned 45 times across the focus group interviews and digital reflections. It was defined as the perception that teamwork and collaboration supported students’ STEM
learning. In the digital reflections, a student wrote, “What I enjoyed about the activities is that it got to work with things today that I haven’t worked with before and also getting to work with someone else. that way we worked as a team.” Another wrote, “Me and Yulissa worked as a team even though we disagreed on a few things we still learned to work it out and get it right.” One student reflected:

What I learn today was building friendship, working together as a team, telling the difference between the crabs and using different technology's. Me and Annika worked together as a team even though we disagree on things we still do our best.

**Developed relationships.** The theme of *Developed relationships* was mentioned 41 times in the focus groups and student digital reflections. This theme was defined as the perception that students developed friendships and built relationships, which supported students’ STEM learning. Students mentioned meeting new people. One focus group participant said, “I enjoyed the geocaching because, I met new people and it was fun because it was like adventurous.” Another stated, “I met a new friend called Jose and other one that help the teachers. His name is Brian.” One student mentioned, “I did, I made some new friendships… I made some new friendships. I met a girl name Mary Anne and she was really nice.” Another student described how she/he developed new relationships:

Well my first day at school I was on the bus and yeah I was on the bus the first day of iQuest. I felt really, I didn’t feel comfortable I mean I was with my friend Kevin and like later on the day we met more people. The next day I met this guy Ariel and Diego, the are one of the funniest I ever met. Also during a couple of days later I met Lesley and Alejandro and I really hilarious. Also my experience here is that I’ve been in AVID before and as my teacher says, first you might not become like friends but in the end you’ll be one big family and that’s what we are right now.

In a final example, a student wrote:
The first day it came here it was so nervously that know one was going to like me but it meet so of my friends from sixth grade and we are having a blast and ever since Wednesday we left we where laughing so hard the my stomach started to hurt. Any way it just might come here when I’m going into eighth grade. So thank you for having me here.

Support provided by use of technology. Three themes were identified for Sub-research Question C (How do participants describe support provided by use of technology?) As reflected in Table 4.7, the three primary themes were technology enhanced STEM learning, technology increased confidence and interest, and technology increased STEM career interest. Table 4.8 shows the frequency with which the themes appeared across the data sources. The three data sources analyzed were two sets of focus group interview transcripts and one set of digital reflections. The digital reflections included five days of participants’ individual reflections.

Table 4.7: Themes and Definitions for Research Question 2: Support Provided by Use of Technology

<table>
<thead>
<tr>
<th>Theme/Subtheme</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology enhanced STEM learning</td>
<td>Use of technology enhanced summer camp participants’ STEM learning</td>
</tr>
<tr>
<td>Technology increased confidence and interest</td>
<td>Technology increased summer camp participants’ confidence and interest in STEM</td>
</tr>
<tr>
<td>Technology increased STEM career interest</td>
<td>Technology increased summer camp participants’ STEM career interests</td>
</tr>
</tbody>
</table>

Table 4.8: Frequency of Themes for Research Question 2: Support Provided by Use of Technology

<table>
<thead>
<tr>
<th>Theme/Subtheme</th>
<th>Number of sources</th>
<th>Total exemplar quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology enhanced STEM learning</td>
<td>3</td>
<td>73</td>
</tr>
<tr>
<td>Technology increased confidence and interest</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Technology increased STEM career interest</td>
<td>3</td>
<td>16</td>
</tr>
</tbody>
</table>
Technology enhanced STEM learning. The most frequently occurring theme for Sub-research Question C was technology enhanced STEM learning. This theme was defined as the perception that use of technology enhanced summer camp participants’ STEM learning. Technology enhanced STEM learning was mentioned 73 times across the focus groups and digital reflections. In the focus group one student mentioned, “The activity has really helped me especially because I got to use a lot of technology which makes me think that science can be really easy because there are many sources of technology.” Another stated, “The activity has really helped me especially because I got to use a lot of technology which makes me think that science can be really easy because there are many sources of technology.” Another student explained, “The technology that was provided to us was really helpful, like the computer, we went into Moodle and then the GPS helped us find the stamps that we needed, so we could win.” One student indicated:

Like also is that technology has made it like better because during the eye dissection we saw a video how to cut it and it made everybody easier like, “Oh? I’m going to do that quicker, and I am going to do it like that” so I already have the idea in my head than like watching like a black and white picture like, “Oh! I can’t describe it.” Well I mostly think, as I said before, is that technology will help science in a way by making your answers correct by data in computers.

A student reflected:

A computer technology that helped me today was the internet because you could use the internet for almost anything so that is very helpful to everyone. Also we got to go on a site on the internet that allowed us to work there.

Another wrote:
G.P.S.s were a very useful tool because they lead us to them, and are also used to giving Longitude and Latitude on Topographic Map, tagging animals, and it prevents from getting lost. The G.P.S. helps find a location by the coordinates of Longitude and Latitude, it helps tell elevation, distance to target, and also includes a compass. The exciting part about today’s adventure was having the joy of solving a mystery. G.P.S.s are very helpful when looking for a location and are powered by satellite waves.

In a final example of this theme, as student reflected

We were able to use technology to make sure are data is correct. For an example we saw a video how to make sure to dissect the cows eye correctly. This is really important because without technology it would if been much harder than just reading directions. Next technology can help me improve in science classes by one checking to make sure my data is correct and to make sure I have the right information and instructions.

Technology increased confidence and interest. The next theme for Sub-research Question C was technology increased confidence and interest. Technology increased confidence and interest was mentioned 18 times across the focus groups and digital reflections. This theme was defined as the perception that technology increased summer camp participants’ confidence and interest in STEM.

One of the students said, “We used a lot of technology. So, if I have a job like for the pediatrician. I'm going to be more confident of using the technology that they have.”

Another said:

Okay I think well, since I came here I feel more confident about science because I wasn’t really used to technology but I learned a new way that science and technology are related even though you don’t always have to use electronics. Since we don’t do a lot of experiments and labs in 7th grade. This brought me here to like a higher level than we did over there.

Another student wrote:
Talents in arts, communication, math, and/or sciences are critical to great computer using experience because it help us come up with many ways things. Such as it helps us look for information that we are searching for. Also it helps us to be flexible in the computer so we can do our own things. In is very critical to use to have great computer using experiences.

In a final example, one student wrote:

The technology that was provided today was very helpful. We used computers, laptops, RFs, and they even gave us our own Kodak cameras. My knowledge in other subjects though come to be very useful when it comes to being able to operate a computer. Which will help me learn new things using a computer.

**Technology increased STEM career interest.** The final theme for Sub-research Question C was *technology increased STEM career interest*. Technology increased STEM career interest was mentioned 16 times across the focus groups and digital reflections. This theme was defined as the perception that technology increased summer camp participants’ STEM career interests. One student said:

It makes me feel more comfortable because, like I said before I already had felt being a doctor, and now I know it involves a lot of Science and now it makes me feel, it won’t be so hard because since Technology helped me, really helped me understand new things. The technology I used when I’m older will definitely help me.

Another stated:

The help it really help me because. I know that maybe when I grow older and I get a career and a job. I might be able to remember the help I got, or I might also have help or and then which I will relate a lot to medicine.

One student explained:

I think that this week really made me want to get a job more in science because before I didn’t really want to get a career in science but now I do. You get to learn more things and like the video conferences that we had with other people in college, explained what they do and that kind of got me interested in some things.

Another described STEM career interest:
Yeah like in the future like she said like being a veterinarian will be really nice because now in 2010 a lot of jobs are not open as they used to be and as I said before like the economy is being really bad and I know it will because I … when I was interested in the politician I had to learn what I would do to change San Diego like what was the main stuff. I mean you see 13 year old kids doing drugs and all the stuff like they’re having sex with the girlfriends but also is that you want to have a good job and like every … there’s no jobs open when you grow up and if there’s, as my aunt says, “Even people who work at technology get paid big money,” and that’s where you want to consider when you grow up and that’s why I think iQuest is trying to make you realize that science and technology jobs will be open for you in the future.

In a final example of this theme, a student reflected:

My favorite person was Maureen Ferran who was a feminist and she studied viruses and bacteria. She is working with a woman who made a vaccine for cervical cancer. She teaches about viruses and molecular biology. In high school, she took the standard subjects of science including biology, chemistry and physics. We were able to use technology to talk to people all around the country and ask them about their careers and fields and the different types of colleges around the country. Now I think I would like to study diseases and bacteria, and then maybe I could be the next person to find the cure for breast cancer.

**Summary of Quantitative Data Analysis**

Students’ attitudes towards science were measured using an adapted version of the Test of Science Related Attitudes (TOSRA) survey before and after attending summer camp, as well as three months later. Each student was asked to rate each specific question on the 28-question survey and indicate their level of agreement with it, on a one to five interval scale. The five answer options were: Strongly Agree, Agree, Uncertain, Disagree, and Strongly Disagree. Since the adapted TOSRA survey contained ten of Fraser’s negatively worded statements to reduce response bias, these items were reverse coded for analysis (Pallant, 2005). These questions are labeled “(reverse coded)” at end of sentence in the summary tables. In the presented data, “pre” refers to administration of
TOSRA survey on the first day of camp, “post” refers to administration of survey on the last day of camp, and “Fall” refers to administration of survey three months after the post administration.

Since the students rated each question in integer increments, the usual data summary techniques were used: calculating the mean score for each question, a mean for the same question later in time, and the difference between the means. This information is particularly useful in establishing whether participation in the summer camp program was able to create a positive improvement in the student’s attitude toward science, based on the activities of the summer camp.

Given that the adapted TOSRA has not been normalized or standardized, non-parametric statistics, specifically the Mann-Whitney U test for unmatched groups, was utilized to analyze survey data for statistical difference/significance. Using this test a Z statistic is calculated for n’s larger than eight. For example, when comparing the pre vs. post data for the question “I like science classes,” it would be possible to decide if a statistically significant difference exists between how the students rated that question before and after their one-week experience at the summer camp.

With reference to the overall study questions, the quantitative measures listed above were used to address research Question 1. Research question one was “How can participation in an informal STEM outreach summer camp help shape URM students’ attitudes about STEM?”

To answer this question, the adapted TOSRA survey questions were divided into six categories: career interest in science, leisure interest in science, enjoyment of science lessons, attitude toward science inquiry, social implications for science, and adoption of
scientific attitudes. Initial data analysis of pre- and post-summer camp results narrowed the data to three focus area categories: career interest in science, leisure interest in science, and enjoyment of science lessons.

As reflected in Table 4.9, in focus area 1 career interest in science, all question items demonstrated a positive trend toward goal. Two questions in this area were found to have a statistically significant difference in building a positive science attitude:

- Number 32, “When I leave school, I would like to work with people who make discoveries in science”
- Number 39, “A career in science would be dull and boring” This question was reverse coded for analysis.

Question 48, “I would like to be a scientist when I leave school” barely fell short of the statistically significant difference with a Z statistics p value of 0.06148, significance being less than .05.

Table 4.9: PRE/POST Summer Comparison Table-Focus Area 1-Career Interest in Science *p< .05 Z Stat. = calculated value of Mann-Whitney comparison test

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre</th>
<th>Post</th>
<th>Diff</th>
<th>Z Stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>32. When I leave school, I would like to work with people who make discoveries in science.</td>
<td>3.48</td>
<td>4.14</td>
<td>.64</td>
<td>-3.34</td>
<td>.001*</td>
</tr>
<tr>
<td>35. Working in a science laboratory would be an interesting way to earn a living.</td>
<td>4.26</td>
<td>4.40</td>
<td>.14</td>
<td>-.72</td>
<td>.465</td>
</tr>
<tr>
<td>39. A career in science would be fun and exciting. (reverse coded)</td>
<td>1.61</td>
<td>1.84</td>
<td>.23</td>
<td>2.02</td>
<td>.043*</td>
</tr>
<tr>
<td>45. A job as a scientist would be interesting.</td>
<td>4.14</td>
<td>4.33</td>
<td>.19</td>
<td>-.98</td>
<td>.327</td>
</tr>
<tr>
<td>48. I would like to be a scientist when I leave school.</td>
<td>3.30</td>
<td>3.70</td>
<td>.40</td>
<td>.06</td>
<td>.061</td>
</tr>
</tbody>
</table>

(Pre n = 50, Post n = 43, scale 1 to 5)
Table 4.10 reflects that in focus area 2 *leisure interests in science*, the majority of question items demonstrated a positive trend towards goal. The only question that exhibited a negative trend was a negatively asked question (number 31), “I get bored when watching science program on TV at home.” This question was reverse coded for analysis. Three questions in this area were found to have a statistically significant difference in building a positive attitude toward science:

- Number 30, “I would like to belong to a science club”
- Number 38, “I would like to do science experiments at home”
- Number 43, “I would enjoy having a job in a science laboratory during my school vacation.

Table 4.10: PRE/POST Summer Comparison Table-Focus Area 2-Leisure Interest in Science

* *p< .05 Z Stat. = calculated value of Mann-Whitney comparison test*

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre</th>
<th>Post</th>
<th>Diff</th>
<th>Z Stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>30. I would like to belong to a science club.</td>
<td>3.36</td>
<td>3.74</td>
<td>.38</td>
<td>-1.96</td>
<td>.049*</td>
</tr>
<tr>
<td>31. I get excited when watching science program on TV at home. (reverse coded)</td>
<td>2.33</td>
<td>2.20</td>
<td>.13</td>
<td>.50</td>
<td>.667</td>
</tr>
<tr>
<td>38. I would like to do science experiments at home.</td>
<td>4.06</td>
<td>4.42</td>
<td>.36</td>
<td>-2.21</td>
<td>.026*</td>
</tr>
<tr>
<td>40. Talking to my friends about science after school would be exciting. (reverse coding)</td>
<td>2.49</td>
<td>2.68</td>
<td>.19</td>
<td>.89</td>
<td>.373</td>
</tr>
<tr>
<td>43. I would enjoy having a job in a science laboratory during my school vacation.</td>
<td>3.72</td>
<td>4.12</td>
<td>.40</td>
<td>-2.06</td>
<td>.039*</td>
</tr>
<tr>
<td>47. I would enjoy visiting a science museum on the weekend.</td>
<td>3.88</td>
<td>3.95</td>
<td>.07</td>
<td>-.24</td>
<td>.803</td>
</tr>
</tbody>
</table>

(Pre n = 50, Post n = 43, scale 1 to 5)
In focus area 3 *enjoyment of science lessons*, all question items demonstrated a positive trend towards goal (See Table 4.11). Two questions in this area were found to be statistically significant in assessing a positive attitude toward science:

- Number 33, “School should have more science lessons each week”
- Number 34, “Science lessons bore me.” This question was reverse coded for analysis.

Question 29, “Science lessons are fun,” barely fell short of the statistically significant difference with a Z statistics p value of 0.0536.

Table 4.11: PRE/POST Summer Comparison Table – Focus Area 3 - Enjoyment of Science Lessons *p< .05 Z Stat. = calculated value of Mann-Whitney comparison test

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre</th>
<th>Post</th>
<th>Diff</th>
<th>Z Stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>29. Science lessons are fun.</td>
<td>4.14</td>
<td>4.47</td>
<td>.33</td>
<td>-1.93</td>
<td>.053</td>
</tr>
<tr>
<td>33. School should have more science lessons each week.</td>
<td>3.58</td>
<td>3.98</td>
<td>.40</td>
<td>-2.17</td>
<td>.030*</td>
</tr>
<tr>
<td>34. Science lessons excite me. (reverse coded)</td>
<td>1.60</td>
<td>1.98</td>
<td>.38</td>
<td>2.13</td>
<td>.032*</td>
</tr>
<tr>
<td>42. I really enjoy going to science lessons.</td>
<td>3.98</td>
<td>4.21</td>
<td>.23</td>
<td>-1.55</td>
<td>.121</td>
</tr>
<tr>
<td>44. The material covered in science lessons is interesting. (reverse coded)</td>
<td>1.74</td>
<td>1.96</td>
<td>.22</td>
<td>1.52</td>
<td>.129</td>
</tr>
<tr>
<td>46. I look forward to science lessons.</td>
<td>4.08</td>
<td>4.30</td>
<td>.22</td>
<td>-1.49</td>
<td>.133</td>
</tr>
</tbody>
</table>

(Pre n = 50, Post n = 43, scale 1 to 5)

The adapted TOSRA survey was administered a third time three months after the post administration. This third administration is referred to as “Fall” measure. Results for all three focus areas revealed a majority of negative trends towards goal.

In the Fall, administration of focus area 1 *career interest in science* the majority question items demonstrated a negative trend toward goal (See Table 4.12). Four out of five questions in this area had a statistically significant difference. The only question
that did not have a statistically significant difference was number 39, “A career in science would be dull and boring.” Question 39 was a negatively-asked question and was reverse coded for analysis. Question 39 barely maintained a positive trend.

Table 4.12: Summer Post vs. Fall Comparison Table-Focus Area 1-Career Interest in Science  *p< .05 Z Stat. = calculated value of Mann-Whitney comparison test

<table>
<thead>
<tr>
<th>Question</th>
<th>Post</th>
<th>Fall</th>
<th>Diff</th>
<th>Z Stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>32. When I leave school, I would like to work with people who make discoveries in science.</td>
<td>4.12</td>
<td>3.00</td>
<td>-1.14</td>
<td>3.86</td>
<td>.001*</td>
</tr>
<tr>
<td>35. Working in a science laboratory would be an interesting way to earn a living.</td>
<td>4.40</td>
<td>3.29</td>
<td>-1.11</td>
<td>4.47</td>
<td>.001*</td>
</tr>
<tr>
<td>39. A career in science would be fun and interesting. (reverse coded)</td>
<td>1.59</td>
<td>1.61</td>
<td>.02</td>
<td>.063</td>
<td>.527</td>
</tr>
<tr>
<td>45. A job as a scientist would be interesting.</td>
<td>4.32</td>
<td>3.18</td>
<td>-1.14</td>
<td>4.36</td>
<td>.001*</td>
</tr>
<tr>
<td>48. I would like to be a scientist when I leave school.</td>
<td>3.70</td>
<td>2.53</td>
<td>-1.17</td>
<td>3.40</td>
<td>.001*</td>
</tr>
</tbody>
</table>

(Post n = 43, Fall n= 17, scale 1 to 5)

As reflected in Table 4.13, in the Fall, administration of focus area 2 leisure interest in science, most question items demonstrated a negative trend toward goal. Similar to focus area 1, the only two items that were not statistically significant in this data set were also the only two items that demonstrated a positive trend toward goal. Moreover, these two items were also negatively asked questions and were reverse coded for analysis:

- Number 31, “I get bored when watching science programs on TV at home”
- Number 40, “Talking to my friends about science after school would be boring”
Table 4.13: Summer Post vs. Fall Comparison Table – Focus Area 2 - Leisure Interest in Science *p < .05 Z Stat. = calculated value of Mann-Whitney comparison test

<table>
<thead>
<tr>
<th>Question</th>
<th>Post</th>
<th>Fall</th>
<th>Diff</th>
<th>Z Stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>30. I would like to belong to a science club.</td>
<td>3.74</td>
<td>2.65</td>
<td>-1.09</td>
<td>3.71</td>
<td>.001*</td>
</tr>
<tr>
<td>31. I get excited when watching science program on TV at home. (reverse coded)</td>
<td>2.06</td>
<td>2.33</td>
<td>2.7</td>
<td>.894</td>
<td>.371</td>
</tr>
<tr>
<td>38. I would like to do science experiments at home.</td>
<td>4.42</td>
<td>3.35</td>
<td>-1.07</td>
<td>4.41</td>
<td>.001*</td>
</tr>
<tr>
<td>40. Talking to my friends about science after school would be exciting. (reverse coded)</td>
<td>2.35</td>
<td>2.47</td>
<td>.14</td>
<td>.303</td>
<td>.761</td>
</tr>
<tr>
<td>43. I would enjoy having a job in a science laboratory during my school vacation.</td>
<td>4.12</td>
<td>3.18</td>
<td>-.94</td>
<td>3.428</td>
<td>.001*</td>
</tr>
<tr>
<td>47. I would enjoy visiting a science museum on the weekend.</td>
<td>3.95</td>
<td>2.88</td>
<td>-1.07</td>
<td>3.52</td>
<td>.001*</td>
</tr>
</tbody>
</table>

(Post n = 43, Fall n= 17, scale 1 to 5)

In the Fall, administration of focus area 3 *enjoyment of science lessons*, all question items demonstrated a negative trend toward goal (See Table 4.14). The only two items that were not statistically significant in this data set were also negatively asked questions and were reverse coded for analysis:

- Number 34, “Science lessons bore me”
- Number 44, “The material covered in science lessons is not interesting”
Table 4.14: Summer Post vs. Fall Comparison Table Focus Area 3 - Enjoyment of Science Lessons

* p< .05 Z Stat. = calculated value of Mann-Whitney comparison test

<table>
<thead>
<tr>
<th>Question</th>
<th>Post</th>
<th>Fall</th>
<th>Diff</th>
<th>Z Stat</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>29. Science lessons are fun.</td>
<td>4.47</td>
<td>3.41</td>
<td>-1.06</td>
<td>4.29</td>
<td>.001*</td>
</tr>
<tr>
<td>33. School should have more science lessons each week.</td>
<td>3.98</td>
<td>2.88</td>
<td>-1.10</td>
<td>3.82</td>
<td>.001*</td>
</tr>
<tr>
<td>34. Science lessons excite me. (reverse coded)</td>
<td>1.82</td>
<td>1.60</td>
<td>-0.22</td>
<td>.828</td>
<td>.407</td>
</tr>
<tr>
<td>42. I really enjoy going to science lessons.</td>
<td>4.21</td>
<td>3.24</td>
<td>-0.97</td>
<td>3.91</td>
<td>.001*</td>
</tr>
<tr>
<td>44. The material covered in science lessons is interesting. (reverse coded)</td>
<td>1.82</td>
<td>1.74</td>
<td>-.08</td>
<td>.476</td>
<td>.634*</td>
</tr>
<tr>
<td>46. I look forward to science lessons.</td>
<td>4.39</td>
<td>3.35</td>
<td>-.95</td>
<td>4.16</td>
<td>.001*</td>
</tr>
</tbody>
</table>

(Post n = 43, Fall n= 17, scale 1 to 5)

Summary

Two research questions were explored in this study. Research Question 1 was “How can participation in an informal STEM outreach summer camp help shape URM students’ attitudes about STEM?” The qualitative data analysis identified five primary themes related to this Research Question 1. The themes were make learning fun, hands-on learning, learn new STEM content, increased interest in STEM-related careers, and increased confidence in STEM learning. The quantitative data analysis of pre- and post-summer camp results narrowed data from adapted TOSRA survey to three focus area categories: career interest in science, leisure interest in science, and enjoyment of science lessons. Overall results of pre and post data found that attending camp made a difference
in building a positive science attitude. However, the post and Fall data revealed that positive science attitude was not maintained upon return to students’ respective schools.

Research Question 2 included 3 sub-research questions. Sub-research Question A was “How do participants describe support provided by institutional agents?” The two themes identified for Sub-research Question A were helpful teachers and staff and staff made learning exciting. Sub-research Question B was “How do participants describe support provided by interpersonal networks?” The two themes identified for Sub-research Question B were teamwork and collaborations and developed relationships. Sub-research Question C was “How do participants describe support provided by use of technology?” The three primary themes were technology enhanced STEM learning, technology increased confidence and interest, and technology increased STEM career interest.

This narrative included tables summarizing the definition of the identified themes and the frequency of occurrence for the themes, as well as tables summarizing quantitative values. Exemplar quotes were also provided as part of qualitative findings.

Chapter five will conclude this dissertation and address the major findings as they connect to the theoretical framework of social capital and STEM. The final chapter will also present conclusions and implications for actions needed in strengthening the Hispanic science pipeline, as well as recommendations for future research.
CHAPTER 5: FINDINGS AND IMPLICATIONS

This chapter presents an overview of the research study including: a statement of the problem, the purpose statement, a review of the methodology, and the dissertation’s research questions. Next, the researcher discusses the findings as they connect to the theoretical framework of social capital. Last, the chapter presents conclusions and implications for actions needed in strengthening the Hispanic science pipeline, as well as recommendations for future research.

Statement of Problem

There is a disparity in the number of Hispanic students attracted to careers in STEM fields as compared to their White counterparts. It is an unfortunate reality that fewer students, especially minorities, are choosing to pursue careers in Science, Technology, Engineering, and Mathematics (STEM) fields. For Hispanic students, it is an even sadder case in that they are short changed of this option prior to completing middle school (Oakes, 2005). Consequently, the National Action Council for Minorities in Engineering (2008) refers to the “4% problem,” meaning that only 4% of underrepresented minorities graduate from high school having met criteria to be “engineering eligible.” Leaders and policy makers can no longer ignore these data. As well, those who lead and who make policy need to understand and act on the fact that diversity drives innovation, a crucial component for competing in today’s global economy (Forbes, 2011). Dr. John Brooks Slaughter (2008), President and CEO of NACME, urges that:
Given that the number of college-age minority students will grow dramatically over the next decade, and that significant gaps in college participation and success exist between them and their non-minority peers, we must find ways to facilitate, rather than deter, their entry into and graduation from STEM disciplines. (p. 5)

Additionally, there is a lack of social capital impeding underrepresented minority (URM) students from obtaining the mathematical and scientific background required to achieve educational and career success in STEM fields. Social capital, as used in this study, is founded on Stanton-Salazar and Dornbusch’s (1995) definition: “social relationships from which an individual is potentially able to derive institutional support, particularly support that includes the delivery of knowledge-based resources” (p. 119). Given that Hispanic youth are least likely to pursue STEM choices, it is important that STEM opportunities are relationship based, not just workforce driven. For example, one of the core design elements of the successful Chicago-based project, Project Exploration, was to build social capital through creating relationships between students and passionate STEM professionals (Lyon, Jafri, & St. Louis, 2012). The program’s STEM learning experiences are designed to support students’ social and emotional development by intentionally structuring relationships among students, staff, and scientists. According to Chi, Goldstein, Lee, and Chung (2010), “Meaningful work with scientists and long-term relationships with caring adults were critical factors in students’ decisions to persist in Project Exploration and in STEM” (p. 50). STEM outreach programs that capitalize on relationships with scientists and institutional partnerships can ensure that students build the social capital needed to strengthen the science pipeline (Lyon, Jafri, & St. Louis, 2012).
**Purpose Statement**

The purpose of this study was to examine the effects of generating and utilizing social capital within an informal STEM summer camp as resources to strengthen the academic pipeline for Hispanic students toward careers in STEM. The researcher intended to gain deeper understanding of how learning science in an engaging, non-traditional setting, such as a university campus, could help shape the attitudes of URM students towards science and making STEM choices. Special attention was placed on students’ interpretation of institutional support acquired through interpersonal networks with key institutional agents (teachers, administrators, college students, and professional STEM role models). Social capital provides funds of knowledge, bridging, role modeling, advocacy, emotional and moral support, as well as building a sense of belonging and helping mitigate social inequalities that preserve URM students’ underachievement and lack of participation in STEM fields.

**Research Questions**

1) How can participation in an informal STEM outreach summer camp help shape URM students’ attitudes about STEM?

2) In what ways does an informal STEM outreach summer program affect Hispanic, middle school students’ levels of social capital?

a) How do participants describe support provided by institutional agents?

b) How do participants describe support provided by interpersonal networks?

c) How do participants describe support provided by use of technology?
**Review of the Methodology**

To address the research questions, this study employed a qualitative research design, specifically an instrumental case study design using mixed methods within a bounded program. Forty-nine Hispanic 7th and 8th grade students from middle schools in San Diego County participated in a week-long STEM outreach summer camp called Investigations for Quality Understanding and Engagement for Students and Teachers (iQUEST) located at California State University San Marcos in July 2010. The iQUEST program was funded by the National Science Foundation, sponsored by California State University San Marcos, and provided at no cost to participants. The participating students were pre-selected by science teachers, technology teachers, and administrators at each of five schools. Participants selected were underrepresented minority (URM) students who had interest and potential in science and technology. Participants were engaged in hands-on, interactive, innovative science and technology activities. They gained valuable university campus experiences and interacted with college students, scientists, professionals, and university faculty, all of whom served as mentors. The ultimate goal of the iQUEST summer camp was to promote interest in STEM careers and strengthen participants’ ability to excel in science and technology during the upcoming school year.

In order to gather detailed information on participants’ perceptions of the development of social capital, qualitative data were collected from multiple sources: survey, focus group interviews, and electronic documents. The researcher also conducted site observations to become familiar with structure of camp and observe student interactions with adults and peers. These observations were used to understand and confirm comments made by participants. Students were interviewed using open-
ended questions after attending summer science camp. Participants reflected on their experiences daily using an electronic journal entry via “Moodle,” a virtual learning environment used by the project. The transcribed interviews and electronic documents were coded and analyzed using NVIVO.

Students’ attitudes towards science were measured using an adapted version of the Test of Science Related Attitudes (TOSRA) survey before and after attending summer camp, as well as three months after the camp. Non-parametric statistics, specifically the Mann-Whitney U test for unmatched groups, was used. The intent was to use Mann-Whitney U as an indicator of statistically significant differences between sets of data.

**Discussion of Findings**

The first research question addressed Hispanic middle school students’ attitudes about STEM. The question examined the following: How can participation in an informal STEM outreach summer camp help shape URM students’ attitudes about STEM? Findings indicate the iQUEST summer program had a positive effect on increasing interest and attitudes of Hispanic middle school students toward STEM choices. Survey data revealed that in the three focus areas of **career interest in science**, **leisure interest in science**, and **enjoyment of science lessons** participants’ attitudes were positively impacted by attending the STEM summer camp (See Tables 4.9, 4.10, and 4.11). According to survey results, participation in summer science camp increased participants’ desires to belong to a science club and to do science at home and during school vacations. The survey results also revealed that participants would like to work with people who make discoveries in science when they leave school and that a career in
science would be fun and exciting. These findings support research that immersion in high-caliber STEM activities positively impacts minorities’ interest in STEM (Chi, Snow, Goldstein, Lee, & Chung, 2010; Rajashankar, Tahernezhadi, & Vohra, nd; Yilmaz, Garcia, Guillen, & Ramirez, 2011). Moreover, the results from the research confirmed that students from underserved populations benefit from out-of-school-time (OST) programs (Lauer, et al, 2006). The findings are further supported by qualitative data collected from focus group interviews and individual student reflections in which students expressed that their participation in iQUEST summer camp positively impacted their interest and attitudes in making STEM choices. One female student enthusiastically shared her interest in science:

We were able to use technology to talk to people all around the country and ask them about their careers and fields and the different types of colleges around the country. Now I think I would like to study diseases and bacteria, and then maybe I could be the next person to find the cure for breast cancer.

During the interviews, students eagerly expressed that their interest and attitudes about STEM choices were reinforced and/or inspired because the iQUEST camp made learning fun, included hands-on learning, helped students learn new STEM content, increased interest in STEM-related careers, and increased their confidence in STEM learning (See table 4.3). Based on survey results, students left their iQUEST summer camp experience feeling excited about science lessons and feeling that school should have more science lessons each week. It was apparent that many students had not experienced engaging, hands-on signs activities that included use of technology on a regular basis at their respective schools. Being able to handle crabs, use technology devices, and work in groups appeared to be a novel experience for many students. When triangulating data
from survey, interviews, reflections, and observations, it was clear that participants were active and engaged learners during science lessons at the summer camp, which in turn, positively impacted their STEM choices.

However, the third administration of the adapted TOSRA survey, referred to as the “Fall” measure, revealed a different story. There was a majority negative trend for all three focus areas of career interest in science, leisure interest in science, and enjoyment of science lessons (See Tables 4.13, 4.14, and 4.15), meaning that the positive effects that summer camp had on students was not maintained upon re-entry to respective schools. The “splashdown effect” described by Stakes and Mares (2003) was not experienced by participants in this study. The “splashdown effect” refers to program-related changes the participants recognize and that become apparent to them after reentry to their home schools. The researcher expected for students’ positive attitudes to continue once they returned to their home school, but this did not seem to occur. It would have been beneficial to the study for the researcher to conduct follow-up interviews with participants at the same time the “Fall” survey was administered. This could have possibly revealed information as to why there was a change in attitude once students returned to respective schools.

The second question of the study investigated the theory of social capital through the following questions: In what ways does an informal STEM outreach summer program affect Hispanic, middle school students’ levels of social capital?

a) How do participants describe support provided by institutional agents?

b) How do participants describe support provided by interpersonal networks?
c) How do participants describe support provided by use of technology? An additional finding suggests that summer camp participants were able to generate social capital in five key forms of institutional support. The forms of institutional support include: (1) emotional and moral support, (2) funds of knowledge, (3) bridging, (4) role modeling, and (5) providing regular personalized feedback, advice, and guidance. There were two key forms of institutional support that were more prevalent than the others: “emotional and moral support” and “funds of knowledge.”

Lyon, Jafri, and St. Louis’ (2012) advocate for STEM learning experiences that support underrepresented minority students’ social and emotional development. Minority students benefit from STEM programs that are relationship based, specifically programs that are intentionally structured to build relationships among students, staff, and science experts. Moreover, this finding supports Chi et al.’s (2010) qualitative results, “Meaningful work with scientists and long-term relationships with caring adults were critical factors in students’ decisions to persist in Project Exploration and in STEM” (p. 50). The caring and supportive learning environment created by adults at the iQUEST summer camp made a significant impact on participants. For example, one student commented, “I think all the teachers helped me, because many of them told me that don’t let other people tell you what you can be.” Students shared and reflected on the fact that the “teachers” were approachable and willing to help if participants had questions. Another student shared, “If sometimes if I would have questions about what we were working out, I would ask the teachers and they would kindly explain it to me.” The participants also expressed their appreciation for building new friendships with adults and peers. A female student candidly wrote in her reflection, “What I learned today was
building friendship, working together as a team . . . Me and Annika worked together as a team even though we disagree on things we still do our best.” It was clear from the qualitative data that building relationships was important to participants in their pursuit of STEM learning.

Participants shared that funds of knowledge acquired during camp increased their confidence levels in pursuing STEM fields. A common statement among participants was that they had never done such high-caliber science activities or utilized technology tools in science during the regular school day. One student commented, “I enjoy the eye dissection because I’ve never done a dissection before” and another student shared, “technology has made it like better because during the eye dissection we saw a video how to cut it and it made everybody easier.” A third student wrote in their digital reflection, “What I enjoyed about the activities is that it [I] got to work with things today that I haven’t worked with before and also getting to work with someone else. that way we worked as a team.” The TOSRA survey results also revealed that students wanted to do more engaging science lessons each week and that engaging science lessons excite them. The type of hands-on, interactive lessons incorporated in the iQUEST summer camp increased participants’ confidence and interest in STEM. These findings confirm results by Krajcik, Marx, Blumenfield, Soloway, and Fishman (2000), which state, “urban middle school students learned from an inquiry-based science curriculum supported by technology” (p. 11). The study results support other research findings that technology-enhanced inquiry science units improved understanding of the more complex science topics (Lee, Linn, Varma, & Liu, 2010) and that technology increases motivation and interest in STEM careers (Miller, Chang, & Hoyt, 2010). A statement from a student
affirms this finding, “without technology it would if [have] been much harder than just reading directions.”

Finally, findings indicate that participating in an informal STEM outreach summer program allowed Hispanic, middle school students’ to utilize and generate social capital in a positive way. Moreover, some of the factors that pose a challenge for Hispanics pursuing STEM such as prior achievement; opportunities to learn math and science; attitudes, beliefs, and perceptions toward STEM; self-efficacy; socioeconomic status; social experiences; and mentoring encounters are related to social capital. The literature revealed that Hispanic youth need early intervention and extra support systems in order to achieve and persevere in STEM fields. The loss of interest noted after three months suggests that the extra support systems in their own schools could have helped these students maintain their interest in science. Therefore, it is critical that institutional agents understand their role in keeping the resource faucet flowing during out-of-school time for Hispanic students. Table 5.1 below outlines the roles of institutional agents and how they are manifested through a set of actions (Stanton-Salazar, 2010). The information in table 5.1 can be used as a resource to provide proper and on-going support to Hispanic students.
<table>
<thead>
<tr>
<th>Institutional Agent</th>
<th>Direct Support</th>
<th>Integrative Support</th>
<th>System Developer</th>
<th>System Linkage &amp; Networking Support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resource Agent</strong></td>
<td>-provides personal and positional resources to students</td>
<td><strong>Integrative Agent</strong></td>
<td><strong>Program Developer</strong></td>
<td><strong>Recruiter</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-coordinates students’ integration and participation in networks and professional venues (professional associations, department, school, etc.)</td>
<td>-develops program that embeds students in a system of agents, resources, and opportunities</td>
<td>-actively recruits students into program, department, etc.</td>
</tr>
<tr>
<td><strong>Knowledge Agent</strong></td>
<td>-knows “the system” -accesses or provides knowledge pertinent to navigating the system</td>
<td><strong>Cultural Guide</strong></td>
<td><strong>Lobbyist</strong></td>
<td><strong>Bridging Agent</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-guides students through new social situations in a particular social sphere -teaches students to identify and interact with key people in cultural sphere</td>
<td>-lobbies for organizational resources to be directed toward recruiting and supporting</td>
<td>-introduces students to institutional agent -has a strong social network -knows what key players do</td>
</tr>
<tr>
<td><strong>Advisor</strong></td>
<td>-helps students gather information -assesses problems and possible solutions in a collaborative manner -promotes and guides effective decision making</td>
<td><strong>Advocate</strong></td>
<td><strong>Political Advocate</strong></td>
<td><strong>Coordinator</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-promotes and protects the interest of “their” students</td>
<td>-joins political action group that advocates for social policies and institutional resources that would benefit targeted groups of students</td>
<td>-assesses student’s needs -identifies resources to address need -provides or accesses institutional resources on behalf of students -ensures student utilizes resources</td>
</tr>
<tr>
<td><strong>Networking Coach</strong></td>
<td>-teaches students how to network with key institutional agents -model appropriate <em>networking</em> behavior -develops relationships with important and influential people</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stanton-Salazar, 2010. A social capital framework for the study of institutional agents in the empowerment of low-status students and youth.
Implications

In recent years, interest in improving the Hispanic science pipeline has been increasing among educators, policy makers, and state legislators. The potential of informal STEM enrichment programs is noted by the findings across multiple studies as a way to influence students’ career choices in STEM fields (Chi, Snow, Goldstein, Lee, & Chung, 2010; Lyon, Jafri, & St. Louis, 2012; Miller, Chang, & Hoyt, 2010; Rajashankar, Tahernezhadi, & Vohra, nd; Yilmaz, Garcia, Guillen, & Ramirez, 2011). Furthermore, common findings of multiple studies stressed that social capital, both at home and outside of it, in the surrounding community, was positively correlated with promoting children’s educational engagement and achievement (Brewster & Bowen, 2004; Coleman, 1987, 1988; Israel, Beaulieu, & Hartless, 2001). Hence, the resource faucet continued to flow during the summer for iQUEST science camp participants because they were able to tap into social capital in the surrounding community. More specifically, participants were able to generate social capital in two key forms of institutional support: “funds of knowledge” and “emotional and moral support.” Therefore, future STEM educational policy needs to focus on providing the kinds of support that generate social capital:

1. Given that access to key forms of institutional support and that the development of supportive relationships with institutional agents are systematically complex and problematic for low-status students (Stanton-Salazar, 2010), STEM programs offered during out-of-school time must be relationship based in order to support young students’ social and emotional development. The recently-adopted next Generation Science
Standards (NGSS) call for the utilization and development of social capital in order to ensure access to all students, including non-dominant student groups. Therefore, institutional agents must be intentional about building students’ social capital through relationships with passionate STEM professionals from local universities, as well as public and private sectors.

2. High-caliber STEM activities must be a part of the science curriculum during the school day to ensure students are increasing their funds of knowledge. Out-of-school time STEM programs do not replace the need for high-quality science instruction during the school year. Providing high-caliber STEM curriculum during the school year will require on-going professional development and support for teachers in STEM, resources and time to prepare engaging science lessons on a regular basis, and investment in appropriate science and technology equipment.

**Limitations of Study**

One limitation of the study is that it was limited to a small number of Hispanic students who were initially selected based on their pre-stated interest and potential in science. The participants in the study did not reflect the characteristics of all Hispanic students and, therefore, the study may not be generalizable beyond this group or setting. Another limitation is the short time frame of the one-week camp, especially given the mixed results of previous studies of such programs, which show no significant effects. Additionally, the limited time frame of the pre-post design may not capture adequately the long-term effects of the program. A final limitation is that students were not assigned a unique login number for TOSRA administration. Therefore, the researcher was unable
to track changes in attitude for individual students. Analyzing individual student results would have allowed the researcher to disaggregate individual school data and to further research instructional practices at specific schools.

**Future Research**

Research on social capital explains that people enlisted in networks with high levels of social capital achieve greater personal success. This study did not focus on institutional agents, but on the participating students. There is limited research on institutional agents’ ability to access and transfer resources on behalf of Hispanic students. Therefore, more research is required in understanding how institutional agents at the school level can raise awareness and coach Hispanic students to generate and leverage social capital that will allow them to thrive in STEM.

Since the researcher expected for students’ positive attitudes to continue once they returned to their home school, but this did not seem to occur, further research in the level of fidelity with which STEM professional development topics are implemented at the classroom level is needed. Additionally, further research would be welcome in the area of challenges educators face in order to implement a high-caliber science program.
APPENDIX A

Introduction

Dear Student:

You are asked to respond to a few questions about science as part of our iQUEST Student Summer Camp at Cal State University San Marcos. Your responses will help us better understand your personal feelings and interest in science. You are not required to take the survey and there will be no negative consequence to you if you choose not to take the survey. We hope you will agree to take this 10 minute survey because by taking the survey, you will contribute to our project evaluation. To indicate you are willing to take the survey, please click on the button below to start the survey. You will be asked to enter a special code in the survey that will be given to you by your instructor.

This survey is confidential and your name will not be used in any of our reports.

Dr. Kathy Hayden and Dr. Youven Ouyang
iQUEST Project Directors
1. Please enter your teacher identification code.

* 

2. Please enter your student identification code.

* 

3. What is your current grade level?

☐ 6th grade
☐ 7th grade
☐ 8th grade
☐ 9th grade
☐ 10th grade
☐ 11th grade
☐ 12th grade

4. Which ethnic group do you feel best describes you?

☐ African American
☐ American Indian or Alaska Native
☐ Asian
☐ Filipino
☐ Hispanic or Latino/a
☐ Pacific Islander
☐ White (not Hispanic)

5. What is your gender?

☐ Male
☐ Female
This test contains a number of statements about science. You will be asked what you think about these statements. There are no “right” or “wrong” answers, just tell us what you think.

For each statement please choose only one response.

5 = Strongly Agree (SA)
4 = Agree (A)
3 = Uncertain (U)
2 = Disagree (D)
1 = Strongly Disagree (SD)

6. Statement

Science lessons are fun. ☐ SA ☐ A ☐ U ☐ D ☐ SD
Science lessons bore me. ☐ SA ☐ A ☐ U ☐ D ☐ SD
Working in a science laboratory would be an interesting way to earn a living. ☐ SA ☐ A ☐ U ☐ D ☐ SD
I dislike science lessons. ☐ SA ☐ A ☐ U ☐ D ☐ SD
When I leave school, I would like to work with people who make discoveries in science. ☐ SA ☐ A ☐ U ☐ D ☐ SD
I get bored when watching science programs on TV at home. ☐ SA ☐ A ☐ U ☐ D ☐ SD
The government should spend more money on scientific research. ☐ SA ☐ A ☐ U ☐ D ☐ SD
I would like to belong to a science club. ☐ SA ☐ A ☐ U ☐ D ☐ SD
School should have more science lessons each week. ☐ SA ☐ A ☐ U ☐ D ☐ SD
Science is one of the most interesting school subjects. ☐ SA ☐ A ☐ U ☐ D ☐ SD

7. Statement

A career in science would be dull and boring. ☐ SA ☐ A ☐ U ☐ D ☐ SD
A job as a scientist would be boring. ☐ SA ☐ A ☐ U ☐ D ☐ SD
I would like to do science experiments at home. ☐ SA ☐ A ☐ U ☐ D ☐ SD
Science lessons are a waste of time. ☐ SA ☐ A ☐ U ☐ D ☐ SD
Talking to my friends about science after school would be boring. ☐ SA ☐ A ☐ U ☐ D ☐ SD
I really enjoy going to science lessons. ☐ SA ☐ A ☐ U ☐ D ☐ SD
This country is spending too much money on science. (SA) (A) (U) (D) (SD)

I find it boring to hear about new ideas. (SA) (A) (U) (D) (SD)

I would enjoy having a job in a science laboratory during my school vacation. (SA) (A) (U) (D) (SD)

In science experiments, I like to use new methods which I have not used before. (SA) (A) (U) (D) (SD)

8. Statement

Money used on scientific projects is wasted. (SA) (A) (U) (D) (SD)

I would enjoy visiting a science museum on the weekend. (SA) (A) (U) (D) (SD)

The material covered in science lessons is not interesting. (SA) (A) (U) (D) (SD)

A job as a scientist would be interesting. (SA) (A) (U) (D) (SD)

I look forward to science lessons. (SA) (A) (U) (D) (SD)

I would enjoy school more if there were no science lessons. (SA) (A) (U) (D) (SD)

I would like to be a scientist when I leave school. (SA) (A) (U) (D) (SD)

I dislike reading newspaper articles about science. (SA) (A) (U) (D) (SD)
APPENDIX B

FOCUS GROUP INTERVIEW QUESTIONNAIRE

Project: Beyond the Classroom: The Impact of Informal STEM Experiences on Student Attitudes and Interests

Time of Interview:
Date: 7/16/10
Place: CSUSM
Interviewer: Lidia Scinski
Interviewee:
Position of Interviewee: 7th Grade Participant

I am doing a study to help me learn more about how students develop social capital in an informal Science, Technology, Engineering, and Mathematics (STEM) Summer Program. I am asking you to help because your perceptions are important. I will be asking you some questions about the program and its impact on your STEM attitude and choices. Remember, these questions are only about what you think. There is no right or wrong answer because this is not a test. Thank you for your cooperation and participation in the interview. The responses provided in this interview will be kept private.

Questions:

1. You were involved in many activities during this summer camp. Describe an activity you will remember for a long time. Why does this one stand out over other things you did in the camp?

2. Do you feel the summer camp activities have made you feel that you can be more successful in science and technology than you were before the camp? If so, explain.

3. Do you think you might consider a career (job) in the future related to science and/or technology because of your summer camp experiences? If so, please explain.
4. Tell me about the friendships you made with others (students, teachers, parents, etc.) in the iQUEST Summer camp?

5. Throughout the camp, you worked with both adults (both in the classroom and through video-conferencing) and other students. Describe the support/help given to you by others (students, teachers, parents, etc.) in the iQUEST summer camp. Support can also be new knowledge or information you didn’t have before.

   a) How does the support/help given to you affect how you feel about science and technology?

   b) How does the support/help given to you affect how you feel about considering a career (job) in Technology and Science?

6. This week you were involved in activities that allowed you to use different technology tools. How does the use of technology in iQUEST summer camp affect how you feel about science and technology?

7. How does the use of technology in iQUEST summer camp affect how you feel about considering a career (job) in Technology and Science?
iQuest Summer Camp Application

Application Deadline: May 1, 2010

In order to be considered for the iQuest summer camp, please submit all of the following:

- Application Form
- Recommendation Form (This is to be filled out by nominee’s teacher or another person who knows the nominee well, such as clergy or youth group leader.)
- Personal Statement Paragraph

Please print in ink!

Name: ________________________________ Gender: M F (circle one)

Parents/Guardian Name: ____________________________ Email: _______________________

Home Mailing Address: ________________________________________________________

City: ____________________________ State: __________ Zip: ______________

Home Phone: (_____) ______________________ Cell Phone: (_____) ________________

School Name: ________________________________________________________________

School City: ____________________________ State: __________ Zip: ______________

Preferred T-Shirt Size: (adult sizes, circle one)  S  M  L

Name of Person Providing Recommendation _______________________________________

Race/Ethnicity (optional – please check one or more that apply to you):

☐ African American  ☐ Arab American  ☐ Asian American  ☐ Caucasian
☐ Hispanic/Latina  ☐ Native American

☐ Other: ________________________________________________________________

Do you receive free or reduced lunch at your school? (optional)  ☐ Yes  ☐ No  ☐ Don’t Know

Has either of your parents completed a 4-year college degree?  ☐ Yes  ☐ No  ☐ Don’t Know

What are your favorite subjects at school?

_____________________________________________________________________________________

What do you normally do during the summer?

_____________________________________________________________________________________

Please complete this form and your Personal Statement Paragraph form and return both to:
Lidia Scinski, Assistant Principal, San Marcos Middle School
650 W. Mission Road
San Marcos, CA  92069-290-2509; e-mail: lidia.scinski@smusd.org
Personal Statement Form

**Personal Statement Paragraph:** In 50 words or less please write why you want to be a part of the iQuest Summer Camp and what you hope to learn from the experience.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

**Required Signatures:**

Applicant Signature: ___________________________ Date: _________________

Parent/Guardian Signature: ___________________________ Date: _______________
APPENDIX D

Recommendation Form
(to be completed by nominee’s teacher)

Application Deadline: May 1, 2010

Name of Nominee: ________________________________________________________________

Name of Person Providing Recommendation: ________________________________________

Title: __________________________ School/Organization: ____________________________

Daytime Phone Number: ___________ _How long have you known nominee? _______

Compared with other students you have taught or known, please rate the nominee to the best of your ability using the scale provided (circle the appropriate number).

<table>
<thead>
<tr>
<th>Statement</th>
<th>strongly disagree</th>
<th>disagree</th>
<th>neutral</th>
<th>Agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Participates in class/organization activities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>B) Works well with others</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>C) Demonstrates enthusiasm for task at hand</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>D) Willing to explore new concepts and ideas</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>E) Listens and is open to others’ ideas</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>F) Able to handle difficult tasks/assignments</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>G) Accepts responsibility for behavior</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>H) Attends school regularly</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

You may also submit a separate sheet of paper (with the nominee’s name on top) with a personal statement regarding the applicant’s interest in mathematics and science, potential for pursuing future academic work in these areas, and/or an experience you have had with the applicant that exemplifies her personality and/or ambition. Thank you for your time.

Signature__________________________________________________
APPENDIX E

CONSENT TO PARTICIPATE IN RESEARCH

STUDENT CONSENT FORM

Invitation to Participate
This Spring you were selected by your school site to participate in an iQUEST Student Summer Camp held at CSUSM in July 2010. During the summer camp, you were involved in many activities using technology and focusing on science. You were asked to take two online surveys about your interest in science and technology at the beginning and end of the camp activities. In addition you may have been invited to participate in a focus group interview.

You will now participate in taking the same online survey for a third time. This time the survey will be taken at a computer lab at your school, during your lunch time. All your responses will be kept private. You will also participate in a focus group interview that will take place at your school, during your lunch times as well. The focus group interview will be recorded and transcribed (typed responses into a word document).

Purposes
The purpose of the surveys and interviews are to better understand how you engage in classroom activities and to identify how summer camp activities impact your interest and/or attitudes in science and technology once you are back at your regular school setting.

Description of Procedures
You are asked to participate in these activities with other students that also attended summer camp. Interviews will take place at your school during your lunch time. Interviews will take place for approximately 20 minutes. You will also take TOSRA survey during lunch (on a separate day). You may eat your lunch during the interview. The survey should take no more than 30 minutes and all responses will be kept private.

Risks and Inconveniences
There are minimal risks associated with this study. Your participation in the surveys and interviews are voluntary. You may choose not to answer any questions that you feel uncomfortable answering. In addition, you may choose to leave the interview or stop the survey at any time. Your name will not be used in any of the project reports.

Benefits
During the interview, you will have an opportunity to share and debrief about the program with other children. You may learn new information by participating with other children in the program. Finally, your opinions and experiences will help middle school teachers and researchers in the future when planning project activities. You may feel positive about being asked your opinion about experiences in the project.
Confidentiality
All evaluation data will be locked in a safe place or saved on a password-protected computer. Assessment data is stored on a secure Web site. All names of participants will be kept confidential and no names will be used in the published reports. Only the researchers and the evaluator will have access to names. Your interview and focus group responses will be kept confidential.

Voluntary Participation
Your participation is voluntary. There are no consequences of any kind if you decide you do not want to participate. At any time, you can stop participating.

Questions
If you have any questions in the future, please contact at 619/520-4804 or lscinski@sandi.net. If you have any questions about your rights as a research participant, you may contact our Institutional Review Board at 760.750.4029, or irb@csusm.edu.

☐ I agree to participate in study research activities (surveys and focus group interviews)

Participant’s Name _____________________________ Date __________

Participant’s Signature _____________________________

Parent Signature _____________________________

Researcher’s Signature _____________________________
REFERENCES


Catsambis, S. (1995). Gender, Race, Ethnicity, and Science Education in the Middle


Beyond the Pipeline: STEM Pathways for Youth Development. *Afterschool Matters, 16*, 48-57.


Taningco, M.T., Mathew, A.B. & Pachon, H.P. (2002). *STEM Professions: Opportunities and Challenges for Latinos in science, technology, engineering and mathematics*. Los Angeles, California: The Tomás Rivera Policy Institute, University of Southern California School of Policy, Planning, and Development


