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Beverley Fiona Hinds

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A Study of the Experience of Female African-American Seventh Graders in a Science, Technology, Engineering, and Math (STEM) Afterschool Program

By

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Dissertation

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Eastern Michigan University

In partial fulfillment of the Requirements for the degree of

DOCTOR OF EDUCATION

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Abstract

The purpose of this qualitative study was to determine what inspires or leads seventh-grade African-American girls toward an interest in STEM, to characterize and describe the context of an out-of-school STEM learning environment, explore the impact on the seventh-grade African-American girls who participated in the program as it relates to individual STEM identity, and identify personal and academic experiences of seventh-grade African-American girls that contribute to the discouragement or pursuit of science and math-related academic pathways and careers.

Notable findings in this study included the following:

1. Participants were interested in STEM and able to identify both external and internal influences that supported their involvement and interest in STEM activities. External influences expanded and elevated exposure to STEM experiences.

2. The MJS program provided an opportunity for participants to overcome challenges related to science and math knowledge and skills in school.

3. The MJS program increased levels of interest in STEM for the participants.

4. All participants increased their capacity to demonstrate increased knowledge in STEM content as a result of the learning experiences within the MJS program, and participants transferred this knowledge to experiences outside of the program including school.

5. The STEM learning environment provided multiple opportunities for participants to meet high expectation and access to engaging activities within a supportive, well-managed setting.
6. The MJS program participants demonstrated behaviors related to building a STEM identity through the components described by Carlone and Johnson (2007), including recognition—internal and external acknowledgement of being a STEM person; competence—demonstrating an understanding of STEM content; and performance—publicly exhibiting STEM knowledge and skills.

The findings in this study suggested that African-American seventh-grade girls interested in STEM are inspired and encouraged to participate in STEM by both internal and external factors. Highly effective afterschool STEM programs increase interest, knowledge and skills in STEM. The capacity for building a STEM identity was expanded as explored/measured by the components of recognition, competence, and performance (Carlone & Johnson, 2007). The learning environment conditions and support for building a STEM identity enhance the pursuit of STEM-related fields for African-American middle school girls. Application of these factors add to the potential for a decrease in the gap of representation of African-American women engaged in STEM.

Future studies may explore how African-American middle schools girls interested in STEM construct identity as it relates to STEM, racial, and gender identity development and how the mentoring experience in afterschool STEM programs impacts the career choices of pre-teaching students.
Dedication

I dedicate this dissertation to Theresa Houston for her inspiration to follow my dreams, relentless support, and unceasing belief in me.
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Chapter I–Introduction

The United States Office of Science and Technology Policy (OSTP) published the most recent strategic plan for science, technology, engineering, and math (STEM) education in May 2013. This report provided a review of the status of STEM in the U. S. and an urgent message regarding the importance of elevating STEM academics to support the economic and environmental development for a viable American society. Increasing the number of underrepresented groups involved in STEM is cited in the OSTP report as one of three critical reasons for the justification of investing in STEM education. The report explicitly indicated that “Progress in STEM is critical to building a just and inclusive society” (p. vii). STEM participation and achievement statistics for women and minorities indicated a gap and substantial underrepresentation in STEM fields (National Science and Technology Council, 2013).

A STEM academic degree is an important milestone in pursuing a STEM career; however, only 2.2% of Hispanics and Latinos, 2.7% of African Americans, and 3.3% of Native Americans and Alaska Natives have earned a first university degree in the natural sciences or engineering by age 24 (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2010). Although women constitute the majority of students enrolled in college and 46% percent of the workforce, they represent fewer than one in five bachelor’s degree recipients in fields like computer science and engineering, and hold only 25% of STEM jobs (Economics and Statistics Administration, 2011).

Equitable representation of women and minorities in STEM fields has been an issue and research topic for the past several decades. A variety of research studies have provided
historical perspectives, and contextual insights toward the understanding of underrepresentation of women and minorities in STEM fields. These studies have mainly focused on gender differences regarding math abilities (Valla & Cece, 2011); stereotypes (AAUW, 2008, 2010; Aronson, 2002); and engagement and interest (Eccles, 2003, 2007, 2009; Wang, Willett, & Eccles, 2012; Jolly, Low, Campbell, & Perlman, 2004). Historically, the participation of women and minorities has been unbalanced and unequal to levels of participation of white men. This unbalance begins during academic pathways in math and science at the middle school level, which then leads to limited high school course selections in math and science, and then restricted access to higher education and careers for STEM opportunities. This domino effect to gate-keeping for higher-level math and science coursework beginning at the middle school level and directly leads to underrepresentation in related careers and academic pathways to science and math fields.

Contrary to the domino effect perspective, the issue is further complicated by the findings of American Association of University Women (2010). The statistical data provided clear information that girls and boys are involved in math and science courses in elementary, middle, and high school in roughly equal numbers; and about as many girls as boys leave high school prepared to pursue science and engineering majors in college. Yet fewer women than men pursue these majors. Among first-year college students, women are much less likely than men to say that they intend to major in science, technology, engineering, or math (STEM). By graduation, men outnumber women in nearly every science and engineering field, and in some, such as physics, engineering, and computer science, the difference is dramatic, with women earning only 20% of bachelor’s degrees. The representation of women
in science and engineering declines at the graduate-level, and this trend is reflected in the workplace (AAUW 2010).

Although the research supported an investigation regarding a history of women and minorities and the underrepresentation in STEM related fields; there were marginal research studies that provided a perspective related to the experience of gender and race for minority women; specifically as compared to the gender or minority studies as two separate areas of investigation. Considerations of gender in science education often ignore issues of race, class, religion, sexuality, or other factors (Atwater, 2000; Russell & Atwater, 2005; Carlone & Johnson, 2007). After a review of the literature, Atwater (2000) stated that science educators need to discuss the ways to infuse ideas (about race, ethnicity, class, and so on) in traditional gender science education research to gain a greater understanding of minority girls and women.

It is important to note that in recent years there have been steady increases (yet small in actual numbers) in the U. S. related to overall participation of women and girls in STEM coursework, higher education degrees, and STEM-related career fields. The National Science Foundation (2013) data illustrated a slight overall increase in the 2010 data that represent women in STEM careers and educational attainment of degrees. Moreover, there have been significant increases that may begin to balance the scale in representation in the areas of natural sciences such as biology and agriculture (NSF, 2013). Although, there have been significant increases in participation in biology and agricultural science, the increases are not significant enough to resolve the gaps that remain in minority and female representation in STEM related fields overall. The issue of underrepresentation for women and minorities still exists (American Association of University Women, 2010; Cheryan, 2012; National Science
Foundation, 2013; Weber 2012). In fact, there are specific fields in science, particularly in quantitative subjects such as physics and mathematics where there has been a decline in enrollment at the college level for women (American Association of University Women, 2010; NSF 2013).

The research studies about women and the STEM gap have covered a breadth and depth of topics and analysis; however, the research regarding minority women and the intersection of race and gender related to science fields is nominal (Malcom, 1993; Atwater & Russell, 2005); and the gaps in representation of minority women, and specifically African-American women are higher than for white women when compared to the population ratios (NSF, 2013).

The issue of disparity related to gender and minority gaps and underrepresentation in STEM is a current concern for the country, particularly important to social and economic vitality (National Science and Technology Council, 2013). From 2010-2020, the STEM fields will show the most rapid growth in available jobs, especially in the industries of scientific, technical, and management consulting; computer systems design, and employment services. Specifically, life, physical, and social science occupations are projected to increase by nearly 190,800 jobs from 2010 to 2020, representing a growth rate of 16%. Growth will be widespread throughout several occupations in this group. Life science occupations will increase by 58,300, driven largely by the need for medical scientists to conduct research and to create new medical technologies, treatments, and pharmaceuticals. Employment in math occupations is expected to grow by 17%, adding 19,500 jobs by 2020. About half of these positions, 9400, will be occupied by operations research analysts. Demand for these workers will increase as technology advances and companies need analysts to help them turn data into
valuable information that can be used by managers to make better decisions in all aspects of their business (US Bureau of Statistics, 2012).

A growth in numbers is needed to address the projected growth in STEM fields and employment needs. However, an increase in the numbers could perpetuate the current situation of underrepresentation if there is not a deliberate effort to balance the diversity in STEM fields and an increase in the number of women and minorities who enter STEM academic pathways and careers. Initiatives to improve participation and success in STEM for minorities and girls have been largely promoted by afterschool programs, which are growing in number and effectiveness to address underrepresentation in STEM. Afterschool programs can support growth and address the gender (and minority) gap because a fundamental strength of afterschool programs is the ability to reach underserved and underrepresented populations (Krishnamurthi, 2013; Afterschool Alliance, 2009, 2011, 2013). These programs have the potential to engage and increase the number of minorities and girls’ involvement in STEM during critical developmental middle school years. A recent analysis of evaluation studies of several afterschool STEM programs showed that high quality programs can lead to increased interest and improved attitudes towards STEM fields and careers, increased knowledge and skills, and increased likelihood of pursuing STEM majors and careers (Afterschool Alliance, 2011b).

**Problem Statement**

According to the National Science Foundation (2013) report entitled Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013, women and three ethnic groups—Blacks, Hispanics, and American Indians—are underrepresented in science and engineering. The lowest levels of attainment of college degrees in the STEM fields for
women are math and computer science, with a further disparity for minority women in these fields. White women represent 32% of the population and 18% are involved in the field of science and engineering. Black women represent 6% of the population; however, only 2% are involved in science and engineering occupations. A report by the Department of Commerce (2011), which focused on the gender gap, noted that women make up 48% of the workforce but only 24% of STEM jobs. These statistics provide incentive to increase access and participation in these areas for underrepresented communities. Increasing access is important for making opportunities available for women and minorities to achieve a diverse, balanced workforce in STEM.

There are social and economic needs to address the skills and participation in the field of science, technology, engineering and math (STEM), and improvement in capacity and performance for U. S. students. Nearly 80% of future careers will require some STEM skills. Women are underrepresented in the fields of science, technology, and engineering and math (National Science Foundation, 2013). African-American women represent 2% of the science and math community yet they are over 6% of the U. S. population. Although numerous research studies provided reason and conditions related to the historical context of the continuing gender gap in STEM, little research provided the context and intersection of race and gender related to the underrepresentation of African-American women. Furthermore, minimal studies represented the perspective and experiences of African-American middle school girls’ who express an interest in STEM.

The issue at the center of this study is the underrepresentation of women, particularly African-American women in STEM, and the lack of participation and choices related to academic pathways starting in middle school that involve preparation and selection of higher
level math and science coursework leading to academic pathways and advanced careers in math and science. This study focused on the learning environment of an afterschool program for African-American girls and provided a platform for their voice and their stories.

The goal of a growing number of afterschool programs addresses the needs for increasing STEM interest and skills and decreasing the gender minority gap. STEM programs are growing in afterschool learning environments to address and support the national and community issues related to a growing STEM economy and the need to fill the gaps of underrepresentation. These important growth factors related to future STEM jobs and to improve social conditions with access to underrepresented populations have led to business, and philanthropic funding for afterschool programs (Krishnamurthi, 2013; Afterschool Alliance, 2012).

Many traditional public schools are unable to confront the issues related to the need to address academic pathways that promote the skills and necessary STEM initiatives to resolve the anticipated increase and demand for STEM related jobs, and building a diverse STEM workforce. K-12 education has suffered from resource restraints of time, funding, professional learning, and curriculum emphasis versus a learner-centered focus (Afterschool Alliance, 2011). Additional supports are needed to assist schools to extend time for learning, and employ qualified personnel with expertise in STEM education. However, programs outside of the regular school day have been specifically designed to address the needs of STEM education through afterschool programs.

Afterschool programs offer both additional time and the opportunity to diversify the approaches for at-risk middle school students’ experience with STEM learning. The design and infrastructure of the curriculum is focused on underrepresented groups and engage
hands-on learning programs to motivate interest and build confidence in STEM (Krishnamurthi, 2013). A recent analysis of evaluation studies of several high quality afterschool STEM programs revealed that these programs lead to increased knowledge and likelihood of pursuing STEM majors and careers (Afterschool Alliance, 2011b).

**Purpose and Contributions**

The study investigated the experience of female African-American seventh graders who participated in a STEM afterschool program. The program was named Mae Jemison STEM (MJS) program as a pseudonym for this study to provide anonymity for the participants. This study also explored and examined the learning environment of the afterschool experience (expectations, equity, technology, support, and management); and identified levels in the development of a STEM identity for African-American girls who participated in the program.

The following goals guided this study:

- Provided an examination of the perspectives and experiences of the participants through the lens of the early adolescence stage of identity formation, and the connections to building a STEM identity.
- Determined what inspires/leads participants toward an interest in science and math.
- Characterized and described the impact of an out-of-school STEM learning environment and explore the context and impact on the participants as it relates to individual identity, and STEM identity.
• Identified personal and academic experiences that contribute to the
discouragement or pursuit of science- and math-related academic pathways and
STEM careers.

Further, this study provided contributions, insights, and practices to support and or
engage female seventh-grade African Americans who express an interest in science and
math. These accomplishments could lead to understanding factors related to the learning
environment, interest, and the development of a STEM identity that potentially provide the
necessary basis for an increase in number, and influence on the success of African-American
girls to become STEM leaders in education and the workforce.

Justification and Significance

In the U. S., the largest growth projected for employment in the decade of 2008–2018
is in STEM job-related fields. However, evidence indicated that current educational
pathways are not leading to a sufficiently large and well-trained STEM workforce. It is
essential that U. S. students are engaged in STEM disciplines and opportunities to inspire and
equip an increase in the number of students to excel in STEM, and that these opportunities
are accessible to a diverse population. Some of the largest increases will be in engineering-
and computer-related fields in which women currently hold one-quarter or fewer positions
(Lacey & Wright, 2009; National Science Board, 2010). The Federal Science, Technology,
Engineering, and Mathematics Education 5–Year Strategic Plan (May, 2013) indicated that
one of the top three reasons for investing in STEM is the disturbing statistics for women and
minorities who are substantially underrepresented in these fields. Women make up half of the
workforce and only 24% of STEM jobholders; African-Americans make up 12% of the
workforce and 2.7% of STEM job holders. The implementation roadmap to increase a
competent STEM workforce includes significant improvement in broadening the participation of underrepresented groups and women in STEM fields (NSTC, 2013).

The opportunity to pursue a career in science, technology, engineering, and mathematics is also a matter of pay equity. Occupational segregation accounts for the majority of the wage gap (AAUW Educational Foundation, 2007) and, although women still earn less than men earn in science and engineering fields and on average, in the overall workforce, women in science and engineering tend to earn more than women earn in other sectors of the workforce. According to a July 2009 survey, the average starting salary for someone with a bachelor’s degree in mechanical engineering was just over $59,000. By comparison, the average starting salary for an individual with a bachelor’s degree in economics was just under $50,000 (National Association of Colleges and Employers, 2009).

The underrepresentation of women and minorities in science, technology, engineering, and math (STEM) has been a long standing issue for several decades in the U.S. Many research studies over the past 50 years explored the possible reasons behind this issue; however, the issue still exists (AAUW, 2004, 2008, 2010; OSTP, 2013). Most of the historical studies regarding women in STEM focus on the perspective and experiences of white women. If and when African-American women and/or girls are included, it is most often as a subsidiary group related to minority women, or African Americans including both males and females.

Early studies that included race and gender as a factor for understanding the representation of African-American women in science and math started in the early 1980s with Kenshaft’s (1981) research on Black women in math, which moved the issue forward regarding the context for African-American women and the relationship of race, gender, and
mathematics. In the 1990s, additional studies emerged with an exploration on the impact of racism for Black women in science. In 1993, Sandra Harding (1993), a prominent feminist, compiled a number of essays that explored racism and the formation and utilization of science. The articles in this collection speak to the complexity for African-American women and the analysis of progress for women and minorities in the field of science. Shirley Malcom (1993) captured the obscurity that reaches beyond the current studies at the time that involved either White women or minorities. Malcom places emphasis on the factors related to women’s education and career success; however, “The problems for Black women in science and engineering were and are still subtle and pervasive” (p. 251).

Recent studies during the past decade provided a perspective elicited from African-American women and girls and STEM, and include topics such as elementary mathematics involvement for African-American girls (Jefferson-Isaac, 2006); Black women’s higher education experiences in STEM (Borum & Walker, 2012); African-American women STEM researchers (Galloway, 2011); and gender, ethnicity, and physics (Rosa, 2013). These studies are mainly qualitative, with the exception of Jefferson-Isaac’s (2006) mixed methods study; each of these studies will be summarized in Chapter II.

Late childhood/early adolescence is a turning point for educational pathways for many youth across ethnicities (Eccles, 1999), where some sustain high aspirations and school engagement, whereas many others become increasingly disengaged, perform more poorly, or engage in more disruptive behavior (Azmitia, Cooper, & Brown, 2009).

Research Questions

The following questions provided the framework for this study:
**Question 1.** What influences African-American seventh-grade girls to select and engage in MJS (an afterschool experience related to STEM)?

**Question 2.** What are the factors that may support/encourage/motivate the African-American girls who participate in the MJS program to engage and/or pursue higher level science and math experiences and courses that may lead to careers in STEM?

**Question 3.** How do the African-American girls who participate in the MJS program identify with STEM as a part of building and creating their own personal identity?

**Question 4.** What are the levels of interest in science and math for African-American girls who participate in the MJS program (before and after the program)?

**Question 5.** How/does the Learning Environment support/encourage/inspire the girls in STEM, based on equity, high expectations, support, activity, feedback, management, and digital access (AdvancED Effective Learning Environment Observation Tool)?

**Conceptual and Theoretical Framework**

The theoretical framework of this study comprised the developmental stage of early adolescence, as described by Erickson’s (1950) psychosocial model of stages; defining factors (Scales & Leffert, 2004); and the development of a science identity, as described by Carlone and Johnson (2007). The combination of these theories supported the context of analysis, as the researcher investigated the experience of female African-American seventh graders who participated in a STEM afterschool program and the impact that this experience had on the development of a STEM identity. The researcher considered the beginning stage of adolescence as a way to understand and frame the development of identity related to math and science.
In addition to the developmental stages theory and STEM identity, the researcher also considered interest and motivation through the expectancy-value theoretical model (EEVT) developed by Eccles (1983) to identify the choices and factors that motivate interest and engagement in STEM; and the potential for the pursuit of higher level science and math experiences.

**Early adolescence identity theory.** The early stage of adolescence is known as a critical time when an individual’s identity forms within multiple domains (Erickson, 1968). According to Erickson’s (1968) psychosocial model of stages, adolescent development signifies a time when adolescents begin to question and investigate the possible roles they may play in adulthood, with questions and explorations about where they fit in or belong in context of the current environment. These explorations often lead to discovery and experimentation with different personal images and exhibited behaviors that expand beyond the immediate understanding of answering questions about who they are and a sense of belonging.

Middle school students typically range in age from 11 to 14 years old, which initiates the beginning stages of adolescence and the formation of identity that leads to early adulthood. The process of identity begins at birth, as relationships are established starting with a mother and other family and friends who expand the social circle of a child (Erickson, 1968). Race and gender are also significant to identity development theory, and this was documented as a part of positive development for African-American children (Erickson, 1968). Erickson identified race and gender as important factors of identity development and noted that these characteristics were important to healthy development in African-American
children. Subsequently, research studies continue to validate that both race and gender are important aspects of identity for ethnic minority females (Carlone & Johnson, 2007 & 2011).

The studies and findings on adolescence identity based on the research of Scales and Leffert (2004) focused on 40 characteristics that have a positive impact on late childhood and adolescence. These characteristics, identified as the Developmental Assets in Youth, led to Scales and Leffert’s (2004) definition of identity as an integrated view of oneself encompassing self-concept, beliefs, capacities, roles, and personal history. The implications of this definition provide a dynamic perspective about the development of identity with both internal and external affective factors versus an isolated individual activity. Identity development is a multi-layered variable that is influenced, directly or indirectly, by the self and the other, whatever that other may be, such as family, friends, school, individual, and shared lived experiences, print and digital media, cultural signs, or communications (Scales & Leffert, 2004).

**STEM Identity – Performance, Recognition, and Competence.** Identity has been framed in the context of understanding that there are specific stages in identity development (Erickson, 1950); and that there are dynamic elements and factors that allow for on-going development throughout early childhood to adulthood. The middle school years, also known as the time frame for early adolescence development, signifies a time when adolescents begin the process of making connections to begin a process to identify who they are, in reference to the world around them. They often explore the possibilities and extensions to their independence and interests. As identity is explored, the environment has an influence on the self-reflection and self-understanding process that begins at this stage (Spearman & Watt, 2013).
Carlone and Johnson (2007) designed a prototype theoretical model of science identity. Their research was grounded by an ethnographic study in science on female college students of color. The female scientist of color is described as a person with a strong science identity including the following characteristics: competent, with the ability to demonstrate meaningful knowledge and understanding of science content and motivated to understand the world scientifically; skillful, with the requisite skills to perform with scientific practices (e.g., uses of scientific tools, fluency with all forms of scientific talk and ways of acting, and interacting in various formal and informal scientific settings); and acknowledged as a science person by the individual self and others (Carlone & Johnson, 2007). The science identity model developed by Carlone and Johnson illustrates three overlapping dimensions of science identity: competence, performance, and recognition, as shown in Figure 1.
The theoretical framework designed by Carlone and Johnson (2007) provides a specific scaffold for a science identity with a clear connection between science identity, gender, race, and ethnic affiliations. The “science identity model is based on an assumption that one’s gender, racial, and ethnic identities affect one’s science identity, a connection hinted at, but not made explicit, in previous literature” (p. 1191). The value in Carlone and Johnson’s longitudinal study of women of color majoring in science at the college level was the explicit considerations for identity, science identity, gender, race, and ethnic affiliations.

The science identity model defined by Carlone and Johnson (2007) was used in this dissertation to address the development of STEM identity for adolescence and to understand how a learning environment may support middle school African-American girls’ pursuit of
science and math academic and career pathways. In this study, the researcher adapted the components of the Scientific Identity design to qualify the development and influences that the MJS program has on the development of a STEM identity for African-American seventh-grade girls. This framework was used as a contextual lens to understand the experiences of seventh-grade African-American girls who participated in an afterschool STEM program and to identify the impact that the experience may have on the development of a STEM identity.

Motivation and Interest in STEM

The expectancy-value theoretical model (EEVT) developed by Eccles (Parsons et al., 1983) was initially created to explain individual and group differences in decisions to engage in achievement-related activities. The initial design suggested that achievement-related choices are connected to individuals’ expectations for his or her performance on various achievement tasks and to his or her perceptions of the importance of these various achievement tasks. The influences identify individual value, perception of probable success, social experiences, and interpersonal reflections on performance history (Eccles, Parsons, & Adler et al., 1983; Eccles & Jacobs, 1987). The initial studies on which Eccles focused related to questions about choices and influences regarding male and female achievement behavior within the contexts of school, occupational/vocational, and social settings. These findings led to a series of studies that concentrated on why females were less likely than males to select STEM as a career choice and subsequently, why females were less likely to enroll in higher level math and science courses in high school and college. The expectancy value theoretical model was influenced by three theoretical perspectives: personal agency and social structure are prime focuses in development; social processes include socialization and internalization; and person-environment perspective about the highest levels of engagement occurs when
individual psychological needs are met. The EEVT model proposes that experiences (positive or negative) in a given setting, such as a learning environment, forms associations for a person’s core beliefs about self-identity (Wang & Eccles, 2011). Eccles and her colleagues have shown that ability self-concepts and performance expectancies predict performance in mathematics. Task values, or the importance of an activity, and how well the activity or objective is met, predict course plans and enrollment decisions in mathematics and physics (Eccles, 1987; Eccles et al., 1983; Eccles et al., 1984). Further, studies have also shown that both expectancies and values predict career choices (Eccles et al., 1994).

**The STEM learning environment.** The environment has an influential impact on the development of identity. At this stage, the formation of identity is formed by interaction and feedback from the environment, and this interaction may influence self-reflections. Investigating the impact of the classroom/learning environment on motivation for science could help identify factors conducive to maintaining and sustaining girls’ interest (Spearman 2011). Researchers must carefully examine the stereotypes and biases that pervade the social context in order to understand the factors that will lead to a balance in diversity regarding the STEM workforce. Encouraging more girls and women to enter these vital fields will require careful attention to the environment in classrooms, workplaces, and throughout our culture (AAUW, 2010).

The participants of this study were seventh-grade African-American girls, aged 12 to 13. The researcher considered the beginning stage of adolescence as a way to understand the development of a STEM identity. Central to the theoretical framework for this study is STEM identity as illustrated in Figure 2. However, the additional theories work to support the identification of how STEM identity is developed for adolescent girls including the
motivation and interest factors that lead to the out of school STEM experience, access to higher level math and science courses, and to STEM academic pathways and careers. In addition, the impact of the learning environment was documented to identify the levels of STEM identity related to three components: recognition, performance, and competence (Carlone & Johnson, 2007).

**Figure 2. Researcher’s Conceptual Framework and Understanding of the Study**

The dynamic theoretical scaffold described was designed to construct and support the investigation of the experience of African-American seventh-grade girls who participated in
a science, technology, engineering, and math (STEM) afterschool program, and to identify the impact this experience has on developing a STEM identity.

The researcher observed the MJS learning environment through the use of the AdvancED Effective Learning Observation Tool™ (eleot™) to capture engagement with activities within the learning environment. Note-taking and recordings were used to document observations. The eleot instrument was selected for a learner-centric approach and structure of the tool. The emphasis of a learner-centric model provided a tool and guide for observing the experience of learners versus the quality and degree of instruction methods. The eleot characteristics are based on research from a variety of classroom observation instruments reflected in the work of Danielson (2007, 2009, 2011); Marzano (2001, 2007); Pianta (2007).

The eleot was developed initially by AdvancED Inc. (2012) as a tool to be used in more than 72 countries during observations of classrooms for accreditation reviews. The eleot differs from other instruments in that the observer is focused on examining student behaviors and involvement, not teachers. There are 30 items within the eleot tool that provide information about a student's experience in the learning environment. Based on pilot testing from more than 1700 classroom observations, the overall reliability of the eleot is .91 (using the Kuder-Richardson Formula 20 aka KR-20), which exceeds the typical minimum threshold for reliability of .70 (AdvancED, 2012).

MJS Program Description

The MJS program was collaboratively developed in 2002 by faculty from two Midwest research universities from two departments, including an Institute for Research on Women and Gender and a College of Education. MJS was developed in response to the
decline in mathematics interest achievement among girls and minority youth during middle school. The mission of the MJS program was initially established to increase the competence and confidence of middle school girls in the areas of mathematics, technology, scientific thinking, and communication by engaging them in experiences that promoted interest in and awareness of STEM related careers. The primary goal of this intervention program was to engage at-risk girls who were potentially talented in mathematics and science. The program was intended to increase the girls’ feelings of competency in mathematics and science and to increase persistence in math and science related courses. The program ultimately was intended to increase the likelihood that girls will pursue math-related career options. The program was initially funded by a National Science Foundation grant; however, this funding ended in 2006, and the program is now funded by other grants, contributions, and fundraising initiatives.

The MJS program was offered at no financial cost, specifically to seventh grade girls and integrated mathematics and science with social science research methods in a single-sex, technology-rich environment. The program activities were facilitated during ten Saturday sessions on a research university campus. The program has served over 800 seventh grade girls and, although the racial demographic of the class fluctuates from year to year, 80% to 90% of the girls have been African American. The program has been replicated at five additional institutions.

MJS utilized strategies to increase participation and achievement of female and minority students in mathematics and science, including small collaborative group work and project-based curriculum related to the participants’ interests and experiences. The participants work in research teams with two university student mentors. A research topic of
mutual interest is selected by each team. Guided by the mentors, the teams develop survey questions related to the selected topic, and the survey is posted on the World Wide Web. The teams use computer applications designed to develop data literacy skills for analyzing and interpreting the data. At the end of the program, teams make public presentations of the findings. In addition to the research project, the program includes a tour of university research laboratories, access to university library resources, informal meetings with female scientific and mathematics researchers, and discussions related to STEM career options.

The MJS program was designed to address the failure of girls to persist in mathematics and science. The elements shown to be effective to achieve this goal in other settings have included single-sex participants (Haag, 1998; Lee & Marks, 1990); small learning groups (Peterson & Fennema, 1985); and use of role models and mentoring (Dubois, 2002; Freedman, 1993; Katayama, 2001; Philip & Hendry, 2001; Sullivan, 1996). The implementation of the program provides training and support for the development of mathematics skills, scientific thinking, and career planning.

In 2008, Parent Chats were introduced as a way to provide education and outreach to the parents of the middle school participants. The Parent Chat provided morning sessions for parents to engage in learning about the program, future opportunities for the participants to continue to stay connected with the program, and college scholarship awareness. More than 200 parents have attended the chats.

A study conducted in 2006 reflected findings from data collected from four cohorts of participants during a two-year period. The pre- and post-program comparisons indicated that MJS had a positive impact on participants' confidence in their ability to do well in mathematics. The positive relationship between confidence and performance has been
demonstrated in numerous studies (Eccles et al., 1983; National Science Foundation, 2000). Similarly, a positive relationship has also been shown between success and future attributions or expectation of success (Eccles, 1987).

The MJS program was also effective in supporting successful completion of a sophisticated project and in increasing the mathematical skill set of the participants in the relatively short time frame of ten Saturday sessions. According to the study, the program did not significantly increase the level of educational or career aspirations. However, there was evidence in the journal reports that suggested that the program activities and the experience with college student mentors, and the opportunity to meet with researchers who served as potential role models, supported the girls' high aspirations and encouraged them in the desired directions.

The qualitative data collected during the 2006 study also revealed that the program influenced participants' knowledge of and appreciation for college life. Although some of the participants in the program had already aspired to achieve a college education, they gained insights into what the college experience might entail and became more knowledgeable about the actual college experience. The qualitative data indicated that the collaborative learning environment and mentoring component contributed to increased confidence and competence. In addition, the program and the companion seminar course for the mentors prepared teacher candidates to understand and address issues of equity and access for diverse student populations related to mathematics, science and technology (Reid & Roberts, 2006).

There was little attrition from the program, and the weekly attendance was consistently high. The only external incentive provided for participation in the program was that the girls who completed the program received a high school-level graphing calculator.
Comments and journal entries from the participants and mentors indicated that the commitment and persistence demonstrated was directly related to the sense of community that developed in the research teams over the course of the program.

Female scientists met with MJS participants to lecture about STEM content and to provide stories about personal career development from girlhood to scientist status. The female mentors were university students with competencies in math and science. The student mentors served as teachers to help the girls develop interest and capacity in mathematics and scientific reasoning. The university student mentors offered an alternative pre-student teaching placement for 163 College of Education teacher candidates.

**Follow-Up with Participants**

Operation Support the Journey (STJ) has been the most recent effort to expand the reach of the MJS program. STJ provides summer experiences on campus and activities throughout the school year to engage previous MJS participants in opportunities to explore various areas of STEM. These events bring participants back to the university campus for a *day in the life* of a STEM student. Activities include lectures by STEM faculty, laboratory and classroom experiences, and tours of STEM facilities. The STJ program expansions increase annually and provide activities that include summer academies, academic year Chats, and continuous mentoring support through social networking sites and current technology. These activities are designed to increase and sustain engagement with STEM during high school years and build capacity to pursue STEM disciplines by increasing knowledge of the personal and academic skills necessary for college admission in STEM-related fields. Continuity throughout high school also includes an opportunity to maintain connections to role models and mentors in STEM disciplines.
The program’s characteristics shown in Figure 3 has been cited at the research university as one of the exemplary outreach programs that serves underserved populations and leads to future academic success.

Figure 3. MJS Program and Supporting the Journey
Chapter II–Literature Review

Gender equity related to the fields of science, technology, engineering, and math (STEM) has been a topic for research studies for several decades. A variety of perspectives and explorations have provided insights to explain the gender gap between women and men related to academic and career choices in STEM. Previous research studies included a close look at the social context of women in American society such as gender roles and stereotypes, sexism, and the history of women’s participation in the education and the workforce. Studies have also investigated male and female cognition (Valla & Ceci, 2011), and gender differences in individual motivation and career choice (Eccles 2002, 2004, 2007). The broad historical approach in previous research spans multiple disciplinary perspectives including feminist theory, psychology, sociology, and biology. The interaction of various disciplines reveals the positioning for a complex issue about underrepresentation of women in STEM with many variables and considerations. Considerations are further complicated when race, such as African-American women in STEM, becomes a factor for consideration of women.

To understand the experience of seventh-grade African-American girls in an afterschool STEM program, the topics for the literature review included the following: a general overview of the underrepresentation of women in science, technology, engineering, and math careers and education; race and gender, minority women and particularly African-American women in STEM; access and equity for middle school African-American girls related to STEM education and career pathways; gender beliefs and interest; and afterschool STEM programs for minority girls. These topics allowed the researcher to explore the context for the study and previous research related to the issues related to the realities of
STEM for girls who express an interest in science and math through participation in an afterschool Saturday program.

**Women and Science, Technology, Engineering, and Math (STEM)**

The gender gap is evident in science, technology, engineering, and math and remains an issue of equity, access, and underrepresentation (National Science Foundation, 2013). However, there is no question that women and minorities have made progress in the areas of STEM in higher education attainment of degrees and the workforce over the past several decades. Statistical data point out an increase of the representation of women in engineering in 2006, as much as 40 times the percentage of women in engineering. For example, in 1970 women represented .05% of engineers, and in 2006 there were 20.2% of women working in the engineering fields (Kessel & Nelson, 2011). The change in women’s participation in the scientific academics and the workforce has been meteoric over the past 40 years, with the exception of highly quantitative fields (Valla & Ceci, 2011).

The dramatic increase in women’s participation in STEM areas in higher education has also led to changes in the workforce. However, when the starting point for women in 1970 was so low, it may appear that the increases have eliminated the gap. In recent research studies it has been proposed that some of these gender gaps no longer exist (Hyde & Mertz, 2009). This consideration may accurately disclose that in the past decade women have earned more doctoral degrees in science than ever before (National Science Foundation, 2013), and in some science fields, such as biology and social sciences, namely psychology, women have earned more doctorates than men (National Science Foundation, 2013). However, these facts do not depict the entire context for women in the larger picture of equity in STEM fields. Women are still underrepresented in scientific and math fields, such as engineering, physics,
and computer science. Although significant numerical and statistical evidence supported the progress toward the reduction of the gap in some areas, particularly in the areas of social science (psychology) and biology, and in the attainment of higher education degrees, the gap remains because of the unbalance of male and female representation in the STEM-related workforce and higher education (National Science Foundation, 2013).

Despite the important gains that girls and women have made in education and the workforce during the past 50 years, progress has been uneven, and certain scientific and engineering disciplines remain overwhelmingly male (Hill, Corbet, & Rose, 2010). The statistical data presented in the publication Women, Minorities and Persons with Disabilities, in Science and Engineering (National Science Foundation, 2013) categorized the U.S. population according to gender and minorities, and compared the population ratio to employment and education in the fields of science and engineering. The findings of these data provided an illustration of the underrepresentation of women and minority women in academic and career fields of science, technology, engineering, and math. Although women are enrolling and completing college degrees at higher rates than men, the percentage of women who complete degrees in math and physical sciences are far below the overall or proportional female presence in university and college settings. Women’s participation in engineering and computer sciences remains below 30%. Since 1991, the proportion of women in engineering has increased, mostly at the master’s and doctoral levels. Women’s participation in computer sciences has increased considerably at the doctoral level (although numbers remain small) but has declined at the bachelor’s degree level (National Science Foundation, 2013).
According to The National Science Foundation (2013), representation of minority women in the field of science and engineering differs from the percentage of the population. Overall, more women than men enroll in college; however, the number of academic degrees that women achieve is significantly below that of men in the physical sciences and math. There has been a decline in the overall numbers of women completing bachelor’s and master’s degrees since 2000, however a slight increase in doctoral degrees (Gunderson, 2011; and AAUW, 2010).

Statistics have generally shown a steady increase and, at times, dramatic increase over the past several decades for women’s participation in STEM academic activities and careers; however, the choices for academic and career path has not met the challenges of balancing the equity scale in STEM-related fields. There is still underrepresentation of women and minorities in career fields of math and science (NSF, 2013; Hill 2012; Valla & Ceci 2011; Association of American University Women et al., 2010). Women have clearly made great progress in earning doctorates in STEM fields; however, at the doctoral level women remain underrepresented in every STEM field except biology (AAUW, 2010).

**African-American Women and STEM**

The number of doctoral degrees in STEM disciplines earned by women from underrepresented groups has also increased during the past four decades; however, these numbers remain a small in proportion to the total, and unbalanced in reference to the proportions of ethnic and gender populations. African-American women earned 2.2% of the doctorates awarded in the biological sciences and less than 2% of those awarded in engineering, computer sciences, the physical sciences, and mathematics (Hill et al., 2010).
The variety of numerous research studies and articles about women in science, technology, engineering, and math related fields span the past 50 years and include a range of diverse disciplines and frameworks, and with the exception of Kenshaft (1981), little emphasis exclusively has been placed on African-American women in STEM until recently. Gender and minority STEM studies often include African-American women as a part of the larger groups of women, minorities, and/or African Americans; however, specification for the consideration for both gender and race has not been addressed until the past 15 years. Few of the studies provided an explicit context and voice for African-American girls or women involved in STEM until the past seven years. Although previous relevant studies included African-American women in frameworks related to gender, racial, or minority group classifications, the particular experience and stories related to this group in STEM is only at the beginning stages.

The content of the most recent extensive literature reviews regarding African-American females in STEM identified the limited studies that provided a context for the consideration for race and gender and underrepresentation for African-American females (Borum & Walker, 2012; Jefferson-Isaac, 2006; Rosa, 2013; Galloway, 2011; Chatman, 2011). All of these researchers provided an example of the relationship and intersection of race and gender through current studies with an exclusive emphasis on African-American women and/or girls in STEM, including topics such as elementary mathematics involvement for African American girls with (Jefferson-Isaac, 2006), Black women’s higher education experiences in STEM (Borum & Walker 2012), African-American women STEM researchers (Galloway, 2011), and gender, ethnicity and physics (Rosa, 2013). In summary, all of these studies are qualitative and provided a voice for African-American women to
describe their experiences and filled a void regarding the absence of their stories and experiences in STEM.

Jefferson-Isaac (2006) examined the experiences of seven fifth-grade African-American girls in elementary mathematics using theoretical frameworks from Black feminist thought, Patricia Hill Collins (1989, 1990, 2000), and culturally relevant teaching, as defined by Gloria Ladson-Billings (1995). The findings of the Jefferson-Isaac (2006) study revealed that African-American girls did not believe in the stereotypes that girls were better than boys, or that White students were better than Black students. Most of the girls thought that they were smarter than boys because they were better listeners, on the basis of school behavior. These girls thought that math was important to tell time, count money, and pay bills. The girls did not view the importance of math beyond usual daily uses.

Audrey Chatman’s (2011) qualitative case study explored factors that affect the mathematical achievement of middle school African-American females. Chatman (2011) explored the perception of the girls’ math experiences and the internal and external characteristics that influenced achievement. The findings of this study identified resiliency factors such as persistence and confidence as essential for improvement in mathematics, and also discovered that external influences, such as the teacher and peers, help to shape attitudes towards mathematics.

Borum and Walker (2012) explored Black women’s higher education experiences in STEM, with particular emphasis on mathematics. This qualitative study examined the undergraduate and graduate experiences of 12 Black female mathematicians. A Black feminist framework embedded with a grounded theory approach was used for the study. The results and findings revealed variations and differences between the women who attended
historically Black colleges and universities (HBCU), versus those who attended a non-HBCU for their undergraduate degree. The women attributed mentorship, a supportive program, and study groups as prime indicators for their success.

Stephanie Galloway (2012) studied the overlapping connections of race, gender, and class for African-American women in her research about STEM in higher education. Galloway (2012) used Patricia Collins’ (1986, 1990, 2000) Black feminist thought, and narrative analysis as the framework to capture and analyze the experiences of eight successful African-American women in the conduct of her research about STEM in a university setting. The findings of this study included the following: gender was identified as more significant than race; Black female mentors were less positive than White females, and Black and White males; academic identities were formed within academic settings; and strategies for empowerment were used to navigate obstacles and academic pathways that lead to success in STEM.

Rosa’s (2013) qualitative study used the critical race theory to explore how Black women physicists described their experiences towards the development of a scientific identity, and how this identity is navigated along with the intersection of identities related to race, gender, and class. Rosa (2013) interviewed six Black women who each held a PhD in physics, astronomy, or a closely related field. The two main outcomes of the study, after interview analysis, revealed the following: multiple social and professional communities to which these women belonged played a role in their science identity; and public policy has an impact on the participation of underrepresented groups in science, particularly after school programs and financial support through higher education.
The recent qualitative studies related to the experience of African-American women began to compile research contributions to establish the context for understanding gender, race, access, and successful STEM involvement for African-American girls and women.

Hanson (2004) said that African-American women expressed higher levels of interest in science than Whites; however, within STEM fields, the proportion of African-American women (and women of color) continued to decline at each level of degree attainment (NSF 2007). These trends transferred to the academic and professional world, with men outnumbering women (73% vs. 27% overall) employed in STEM careers (NSF 2007). According to NSF (2007), there has been an increase in African American men and women in some science and engineering fields over the last 25 years. In fact, the proportion of science and engineering occupations has more than doubled for African-American men and women; yet, racial disparities remain in some science and engineering fields. The proportion of science and engineering occupations has more than doubled for African-American men and women, yet racial disparities remain.

In 2010, African-American women represented 6% of the population, and 2% of engineers, (National Science Foundation, 2013). In 2011, NSF reported that the percentages of minority enrollments, including African-American women in STEM disciplines did not parallel minority representation in the U.S. population. According to the National Center for Education Statistics (NCES, 2002), African Americans, represented 12% of the U.S. population and 11% of all students pursuing post-secondary education. In 2002, African Americans earned 7% of all STEM bachelor’s degrees, 4% at the master's degree level, and a mere 2% of doctorate degrees (NCES, 2002).
Access and Equity in STEM Education for African-American Girls: Achievement and Attainment

The trends regarding math and science academic and career path involvement for women and girls represents the long-term influence of early gender differences in primary education. According to the American Association of University Women (2010) and NSF (2007), two-thirds of boys and girls express early interest in science. This indicates that boys and girls are equally interested in science early in their education; however, socialization practices and the culture of schools create differences in how boys and girls express their levels of interest in science. A similar pattern exists among women of color and ethnic racial differences.

The path from elementary school to a STEM career has often been compared to a pipeline (Hill et al., 2010). This metaphor suggested that there are steps and stages that flow together as a progressive conduit that supports academic involvement in STEM and leads towards STEM-related careers. In other words, as the number of girls who study STEM subjects in elementary, middle, and secondary school increases and become more involved in science and math, more girls will enter the pipeline. This would lead to an increase in the number of women who come out of the pipeline to become scientists and engineers, and would also increase the representation of women in STEM careers; then gender disparities in representation would disappear. Based on the involvement of girls’ achievement and participation in science and math, there is a disproportion of women in STEM, and the pipeline metaphor is not working for girls. There appears to be a breakdown in the pipeline for girls. The anticipated balance of representation is not happening at the expected rates based on the pipeline metaphor (Hill, et al., 2010). The faulty pipeline is further accentuated
by the findings that identify young African-American women as expressing more interest in STEM fields than do young White women (Hanson, 2004; Fouad & Walker, 2005). However, the proportionate number of African-American women in STEM remains low, indicating that other barriers are significant for African-American girls and women. (Hanson, 2004; Fouad & Walker, 2005; Hill et al., 2010).

According to the College Board AP* (2006), the percentage of females taking math/science Advanced Placement Exams has grown from 45% to 49%. Further, the proportion of females and males who participate in the AP program is greater. More than 6% (6.1) of female high school students take an AP exam, compared to 4.3% of males.

Differences among students with comparable levels of readiness for advanced placement STEM course work varies significantly across race and gender. For example, the ratio of participation in AP course work in mathematics varies among students who have at least a 60% likelihood of succeeding on an AP mathematics exam: 6:10 Asian students, 4:10 White students, 3:10 Black/African-American and Hispanic/Latino students, and 2:10 American Indian/Alaska Native students. In most AP STEM subjects, female students participate at lower rates than male students (College Board AP*, 2011).

Access to Advanced Math and Science – Tracking in Middle and High School

Minority students are less likely to have access to advanced courses in math and science in high school, which negatively affects their ability to enter and successfully complete STEM majors in college (Frizell & Nave, 2008; Tyson, Lee, Borman, & Hanson, 2007; Perna et al., 2010).

Access to advanced level courses is framed by the process of tracking in schools, where students are provided or denied the opportunity to complete higher level or accelerated
courses on the basis of achievement and/or teacher recommendation. Tracking is a common long-standing practice firmly established as an organizational practice in the U.S. (Abu El-Haj & Rubin, 2009; Mayer 2008). Many schools practice tracking in a variety of frameworks. This method of separating students is rooted in the belief that lower-performing students must be separated from the higher-performing students and provided a simplified curriculum so that the higher-performing students are not held back (Callahan, 2005). There was little evidence that supports ability groupings as a system that produces higher academic achievement compared to mixed heterogeneous groups (Biafora & Ansalone, 2008; Colestock & Gamoran, 2009). However, a few studies defended tracking and report that students of all performance levels were hindered by the heterogeneous grouping. The results of the studies that supported tracking indicated that the performance of at-risk student performance declined in mixed-ability groups (Schweiker-Marra & Pula, 2005); and the higher-achieving students experienced slower gains in the mixed-group setting (Argys, Rees, & Brewer, 1996). Researchers opposed to tracking argued that the practice is unfair and perpetuates inequalities within society, and that tracking is a strategy to sort students by race and class on the basis of the proportions of minority and lower socioeconomic status students who are in the advanced classes (Colestock & Gamoran, 1995; Nunez, Sparks, & Hernandez, 2011). Furthermore, inequities for students exist in the quality of instruction, rigor of curriculum, and level of positive social interactions outside of the advanced courses (Nunez et al., 2011).

Although the term tracking is no longer used in American schools, the implementation of this practice is used to separate students according to ability level and/or on the basis of teacher recommendations for placement in a specific course that determines
access to higher level classes. Tracking is evident in 95% of middle and high schools in North America (Schweiker-Marra & Pula, 2005). In 2007, the National Assessment of Educational Progress (2010) identified 75% of schools nationwide that tracked eighth grade math classes. This may not determine the comprehensive identification of courses that a student takes outside of the specific course; however it determines a specific pathway for subjects and is commonly used for advanced math (and English courses) and begins a sequence for access to higher level courses in these subjects.

The emphasis on higher level math courses begins in middle school, and this is a critical time because late childhood/early adolescence is a turning point for educational pathways for many youth across ethnicities (Eccles, 1999), where some sustain high aspirations and school engagement, whereas many others become increasingly disengaged, perform more poorly, or engage in more disruptive behavior (Azmitia, Cooper, & Brown, 2009).

The research was clear that high school course selections have a direct impact on the pursuit of continued education and career selection in math and the sciences. Specifically, additional electives and the number of math and science classes taken in high school have an impact on the advancement for women to pursue science-related career choices (Farmer, Wardrop, Anderson, and Risinger, 1995; Trusty, 2002).

**STEM: Gender and Race**

Many research studies investigated access to higher level courses for minorities based on racial groups; and these findings indicated that African Americans, Hispanics, and Native Americans are not involved in high level math courses at the same rates as White students. In 2005, 31% of Asian American and 16% of White high school graduates completed calculus,
compared with 6% and 7% of African-American and Hispanic high school graduates, respectively. Additionally, one quarter of Asian American and one tenth of White high school graduates took either the AP or International Baccalaureate exam in calculus, compared with just 3.2% of African-American and 5.6% of Hispanic graduates (National Science Board, 2008).

The research regarding gender was not as extensive as race studies regarding access to higher level course work. The dynamics for girls and higher level math classes are different from those of race. Gender studies indicated that girls are increasingly more involved in higher level course work; however, they do not select the advanced classes in high school and college. Even among underrepresented racial-ethnic groups, a growing number of girls are leaving high school well-prepared in math and science and capable of pursuing STEM majors in college (American Association of University Women, 2010).

An insignificant or zero difference exists in high school and college grades among males and females; and specifically, no difference in standardized math assessments that demonstrate ability levels and performance (Hyde, Fennema, & Lamon, 1990; Hyde & Grabe, 2008). However, there is a clear indication that girls and African Americans do not select advanced math and science-related courses in high school, and this leads to restricted college options and STEM-related career fields.

Carlone and Johnson (2007) designed a prototype theoretical model of science identity for understanding the science experiences of successful women of color. Their research was grounded by an ethnographic study in science on female college students of color. The female scientist of color is described as a person with a strong science identity including the following characteristics: competent, with the ability to demonstrate
meaningful knowledge and understanding of science content and motivated to understand the world scientifically; skillful, with the requisite skills to perform with scientific practices (e.g., uses of scientific tools, fluency with all forms of scientific talk and ways of acting, and interacting in various formal and informal scientific settings); and acknowledged as a science person by the individual self and others (Carlone & Johnson, 2007).

The science identity model developed by Carlone and Johnson (2007) illustrates three overlapping dimensions of science identity: competence – individual knowledge and understanding of science; performance – social demonstration of relevant scientific practices including ways of talking and using tools; and recognition - recognizing oneself, and getting recognized by others as a science person, as shown in Figure 1. The results of the findings identify competence and performance components as necessary to a science identity, whereas, recognition is a predictor of the development of a science identity for women of color.

In addition to the original study using the science identity prototype model, another study was conducted by Carlone, Johnson, Brown, and Cuevas (2011). This qualitative study explored the identity processes of three women of color who completed advanced degrees in science. The findings provided an illustration of the struggles facing racial and gender specific exclusions and challenges as well as the success to becoming a scientist. The researchers expressed concern for the obstacles that were overcome in order to achieve these results and captured this idea in the conclusion of the study.

Even though these three women succeeded, this is not justice, and in the end, it is not for the greater good. To borrow a metaphor of Jones (2000), “just because these women were
able to bloom from dry, rocky soil, and bloom as high as others planted in better soil, does not make it fair” (p. 363).

**STEM: Gender Beliefs and Interest, Motivation, and Stereotypes**

Numerous research studies indicated that the decline in performance, interest, and motivation for students begins in the middle school years; this is the turning point when students begin to fall away from high school graduation. Sixth graders who failed math or English/reading, attended school less than 80% of the time, or received an unsatisfactory behavior grade in a core course had only a 10 to 20% chance of graduating from high school on time (Balfanz, 2009). The research regarding interest in science and engineering typically ignored considerations for gender, race, and ethnicity simultaneously. Notions about the differences between women’s interests and STEM have mostly been based on the understanding of White women’s experiences. However, some theorists’ such as Eccles (2006, 2009) have extended critical foundational models of motivational studies to include the impact of race and/or racial/ethnic identity as an additional element to understand the value and personal identities that lead to engagement and achievement.

**Beliefs and interest.** Cheryan (2012) described math-gender, beliefs about math intelligence, stereotypes, and media images as having a negative impact on female selection of math-related careers and interest in STEM. These characteristics have steered women away from selecting science and math-related fields and hindered female performance. The understanding and messaging about the feminine aspect of science and math-related fields has provided images of a gender-based interpretation of a scientist or mathematician as a male area (AAUA, 2010). Gender roles that are culturally prescribed also influence
occupational interest (Low, Yoon, Roberts, & Rounds, 2005). A review of child vocational
development by Hartung (2005) found that children, and girls especially, develop beliefs that
they cannot pursue particular occupations because they perceive them as inappropriate for
their gender.

Pajares (2005) identified gender differences in self-confidence in STEM subjects that
begin in middle school and increase in high school and college, with girls reporting less
confidence than boys do in their math and science ability. Students who lack confidence in
their math or science skills are less likely to engage in tasks that require those skills and will
more quickly give up in the face of difficulty. Girls and women may be especially vulnerable
to losing confidence in STEM areas (Pajares, 2005).

On the other hand, African-American culture promotes the belief that African-
American girls and women should have characteristics such as high self-esteem,
independence, and assertiveness, and these qualities are considered appropriate for African-
American women; these characteristics can lead to success in STEM fields (Hanson, 2004).
Young African-American women expressed more interest in STEM fields than young White
women (Hanson, 2004; Fouad & Walker, 2005). However, the proportionate number of
African-American women in STEM remains low; indicating that other barriers are significant
for African-American girls and women. (Hanson, 2004; Fouad & Walker, 2005; Hill et al.,
2010).

The research of Carol Dweck (2006) regarding mindset and beliefs related to a fixed
or growth mindset has implications for improving self-confidence. Dweck’s research
indicated that when a girl believes that she can become smarter and learn what she needs to
know (growth mindset) in STEM subjects, as opposed to believing that a person is either
born with science and math ability or not (fixed mindset), she is more likely to succeed in a STEM field. A belief that one can succeed in a STEM field is important but is not the only factor in establishing interest in a STEM career (Hill et al. 2010). The findings from the published report by the American Association of University Women entitled Why so few? Women in Science, Technology and Engineering (2010) suggested that creating environments that support girls’ and women’s achievements and interest in science and engineering will encourage more girls and women to pursue careers in these vital fields.

**Motivation and engagement.** The expectancy-value theoretical model (EEVT) developed by Eccles [Parsons] et al., (1983) was initially created to explain individual and group differences in decisions to engage in achievement-related activities. The initial design suggested that achievement-related choices are connected to individuals’ expectations for their performance on various achievement tasks and to their perceptions of the importance of these various achievement tasks. The influences identify individual value, perception of probable success, social experiences, and interpersonal reflections on performance history (Eccles, Adler, & Futterman, 1983; Eccles, 1987). The initial Eccles studies focused on questions about choices and influences regarding male and female achievement behavior within the contexts of school, occupational/vocational, and social settings. This led to a series of studies that concentrated on why females were less likely than males to select STEM as a career choice; and subsequently why females were less likely to enroll in higher level math and science courses in high school and college. The expectancy value theoretical model was influenced by three theoretical perspectives: 1) personal agency and social structure are prime focuses in development; 2) social processes include socialization and internalization; and 3) person-environment regarding the highest levels of engagement occurs when
individual psychological needs are met. The EEVT model proposes that experiences (positive or negative) in a given setting, such as a learning environment, forms associations for a person’s core beliefs about self-identity (Eccles & Wang, 2011). This is illustrated in the EEVT model in Figure 4 and identified as the ‘individual’s affective reactions and memories’.

Eccles and her colleagues have shown that ability self-concepts and performance expectancies predict performance in mathematics. Task values or the importance of an activity and how well the activity or objective is met predict course plans and enrollment decisions in mathematics and physics (Eccles 1987, Eccles et al., 1983, Eccles et al., 1984, Meece et al., 1990). Researchers have also shown that both expectancies and values predict career choices (Eccles et al., 1998a).
Figure 4. Eccles et al., 1983 Expectancy Value Model of Achievement Behaviors

In a recent study, Eccles, Wong, & Peck (2006) explored ethnicity as a social context for the development of African-American middle school students. Central to this study was the impact of racial discrimination as an influential factor on motivation and performance. The longitudinal study included an economically diverse sample of African-Americans. The data were collected at the beginning of the seventh grade and after the completion of the eighth grade. As expected, the experiences of day-to-day racial discrimination at school from one’s teachers and peers predicted declines in grades, academic ability self-concepts, and academic task values. A strong, positive connection to one’s ethnic group (our measure of ethnic identity) reduced the magnitude of the association of racial discrimination experiences with declines in both academic self-concepts and school achievement.
Afterschool STEM Programs

Afterschool programs are serving 8.4 million students and provide a range of programs including homework support, tutoring, and enrichment activities for at-risk youth (Afterschool Alliance, 2013). Research studies revealed that afterschool programs provide a child- or youth-centered approach versus a curriculum that drives the program (McLaughlin, 2000). Afterschool programs deliver a wide range of programs, schedules, and activities with a variety of goals and missions, and are offered through numerous groups of stakeholders. The programs and services for afterschool programs may be provided by school systems, universities and colleges, non-profit organizations, or a combination of these groups (Gootman, 2000; Miller 2003). Afterschool programs complement and supplement learning and are designed to engage and motivate at-risk students. Successful afterschool programs are not the same as the usual school day. Academic skills are important, however personal relationships, program selection based on interest and individual talents, and a focus on building self-confidence and self-efficacy in academics have been identified as conditions that support effective afterschool programs meeting specified goals and missions (Huang & Cho, 2009). According to Miller (2003), an afterschool program that involves “caring adults and small groups” allows under-achieving students to feel “connected” (p. 22). Many of the situations at-risk students face–single-parent homes, poverty, and cultural differences–can be diminished through the involvement in an effective afterschool program (Huang & Cho, 2009; Jenner & Jenner, 2007).

Additional research studies focused on the effectiveness of afterschool programs and the relationship between student participation in afterschool programs and academic achievement, social and emotional learning, and in-school behavior. Increased measures of
accountability have influenced numerous studies with emphasis on achievement and solving social issues (Huang & Cho, 2009; Jenner & Jenner, 2007; Vandell, Reisner, & Pierce, 2007; Afterschool Alliance, 2011). There are mixed results in effectiveness of afterschool programs ranging from having a significant impact to having no impact at all (Jenner & Jenner 2007). McLaughlin (2000) described the range in effectiveness in terms of whether or not the program was actually selected by the participant rather than a required placement.

Afterschool and community programs with an emphasis on STEM learning opportunities have become widely recognized as significant experiences for low-income and minority youth. The emphasis for afterschool STEM opportunities has supported populations underrepresented in STEM fields, with opportunities to explore and engage in these fields. (Afterschool Alliance, 2011). The frameworks for STEM programs in minority or low-income communities are designed and promoted to address the lack of access that low-income and/or minority students may have within the traditional public school setting due to curriculum resources, sub group/gender achievement gaps, or fiscal restrictions. These programs provide an opportunity for a learning environment that takes place outside of the school setting and may be before or after the school day; during weekends, school breaks (spring and winter), or the summer. This experience provides an out of school STEM opportunity that is most often a free program and, similar to affluent peers in that the afterschool programs, provide access to the world of science with meaningful experiences that potentially lead to experiences in the future (Rahm, Moore, & Martel-Reny, 2005). High-quality STEM afterschool programs produce positive outcomes including the improved attitudes toward STEM fields and careers, increased STEM capacities and skills, and increased likelihood of graduation and pursuing a STEM career (Velez, 2011; Aronson,
2008; **Mielke, LaFleur, & Sanzone**, (2010); Nelson, 2011 Afterschool Alliance, 2011). For example, 60% of former Project Exploration participants enrolled in a four-year college in pursuit of a degree in the STEM fields (Project Exploration, 2011).

Organizations such as The Afterschool Corporation and Afterschool Alliance have been committed to documenting and evaluating the effectiveness of the numerous programs to advance afterschool STEM education opportunities for underrepresented at-risk children and young people across the country.
Chapter III—Methods

A qualitative research design with the use of a phenomenological approach was selected for this study. The data provided a description of the experiences of female African-American seventh graders related to an afterschool STEM program for at-risk girls; the impact that the Mae Jemison STEM (MJS) program had on the development of a STEM identity, as expressed through the voices of the girls; and how the experiences in the afterschool program affected their interest in STEM. Prior to the actual study and process for data collection, the researcher received approval from the Eastern Michigan University’s Human Subject Approval Committee (See Appendix A).

Methods

The study used a qualitative method designed to explore the identity development of participants related to STEM experiences in the MJS program. Data were collected through learning environment observations, focus group interviews, journals, video recordings of final presentations, and MJS artifacts and documents related to the experiences of the seventh grade African-American girls attending the MJS program as the 2014 cohort. The study included intensive analysis regarding STEM interests of the girls who participated in the MJS program and the experiences in the program that influenced the development of a science and math/STEM identity in order to explore the impact of the MJS learning environment.

The data for this study were collected on-site during the MJS program. To gather data for this study, the subjects were involved in group discussions and focus group interviews, journal responses, and participation in the learning environment. The researcher attended all of the MJS sessions, which included 10 Saturdays for the participants, and 12 Saturdays for
the mentors. The researcher participated in a total of 50 hours with the participants and an additional 20 hours observing the mentor preparations and discussions.

The 2014 MJS cohort included 62 girls, divided into six teams; two mentors were assigned to each group with additional volunteers. The data collection for this study was on-site and within the environment where the girls experienced the MJS program. The researcher was immersed in the natural setting where the participants experienced phenomena, as a direct result and in support of qualitative concepts and processes for data collection (Creswell, 2013). Also, according to McMillan and Schumacher (2006), qualitative research is “inquiry in which researchers collect data in face-to-face situations by interacting with selected persons in their settings” (p. 315). The researcher was unobtrusive within the participants’ environment but was directly engaged with the focus groups and discussions with participants.

The setting of the environment and participation and engagement levels of the girls was observed and documented through the use of a framework developed by Advance Education Inc. (AdvancED), known as the Effective Learning Environment Observation Tool (eleot). This tool will be described later in this chapter.

**Rationale for a Qualitative Study**

The purpose of this qualitative study was to seek out personal experiences as a way to gain a deeper understanding of an individual’s perspective, and to interpret the collective experience of the participants. The qualitative design selected for this study allowed the researcher to examine the individual and collective experiences of the participants. Creswell (2013) identified qualitative design within a framework of five traditions: narrative, grounded theory, case study, ethnography, and phenomenological. The phenomenological inquiry
approach was selected to make meaning of experiences of several individuals, and to gain an understanding of that experience (Hatch, 2002). This study connected the experiences of participants to a shared phenomenon, the MJS afterschool program.

This study was aligned with the characteristics of a qualitative study as identified and described by Creswell (2013). The qualitative study data collection process was conducted within a natural setting where the researcher was a key instrument, and multiple methods (interviews, observations, and documents) reasoning was used through inductive and deductive logic. The researcher used participants’ meaning with an emergent design, of reflexivity for the researcher to position herself in the study to provide a holistic account, Creswell (2013).

The phenomenological focus of this study provided a framework to implement procedures by which to explore and gather data from individuals to describe behavior (Bryant, 2004). The researcher was primarily concerned with the process; deriving meaning was the intended outcome for the data collection (Merriman, 1988). This type of research involved fieldwork, and included an emphasis on a descriptive and inductive approach (Merriman, 1988). The qualitative design involved the naturalistic setting of the MJS program, where the participants were engaged. The researcher was directly involved in on-site fieldwork with the participants, where their experiences were mainly captured by note-taking, and audio recording devices for the final presentation (Bogdan & Biklen, 2007). Qualitative research allows for rich thick descriptions from participants (Creswell, 2013). The researcher collected and provided detailed explanations and depictions of the girls’ experiences as it was communicated through the voice of seventh-grade African-American girls.
Participant Selection and Participation

A purposeful sampling strategy was used for the selection of participants from the 2014 cohort of the MJS program for this study. The criteria for acceptance and participation in the MJS program included being a seventh grade at-risk girl from one metropolitan area in the Midwest.

Participation in the study required written permission from the parents/guardians of the participants and from the participants. Informed consent letters were provided for parents/guardians, participants, mentors, and volunteers (See Appendix B). Although the study was not focused on the mentors or volunteers, the researcher recorded observations during the professional learning for the mentors, and during times when the mentors were involved in facilitating the activities, discussions, and exploration of STEM through program lessons with the participants.

After agreement and consent to participate in the study parents/guardians, participants, and/or mentors had the option to withdraw their participation at any time. The opportunity and option to withdraw from the study at any time after consent was clearly communicated during the initial presentation/overview of the study and informed consent process, and written in the informed consent forms (See Appendix C). Individual participants were anonymous, and the researcher protected the anonymity of their involvement and contributions towards the study.

Data Collection and Analysis

The phenomenological approach of data collection has been framed by the model outlined by Moustaka (1994) and Miles and Huberman (1994).

Data collection and analysis procedures included the following steps:
Step 1 – Preparation to collect data: formulation of the question(s), literature review, participant selection criteria, instructions, and guided questions for interviews.

Step 2 – Data collection: engage in Epoche process, defined by Moustakas (1994), is a process of setting aside predilections, prejudices, and predispositions; allowing all things, events, and people to enter anew into consciousness; and to look to see them again, as if for the first time; bracket the question; conduct interview.

Step 3 – Data analysis and synthesis: textural and structural descriptions, and identification of the essence.

Step 4 – Summary and implications: summarize study, relate findings to literature, future research, and professional outcomes for future goals.

Furthermore, the researcher selected a specific approach for data management, analysis, and synthesis framed by the work of Huberman and Miles (1985, 1994). This multilayered contextual process for qualitative designs was identified after a comprehensive study of qualitative procedures for data analysis and assessing approaches to operationalize local causality (Huberman & Miles, 1985). Data management is defined as a systematic, coherent process of data collection, storage, and retrieval. These operations are aimed at ensuring (a) high quality accessible data; (b) documentation of analyses; (c) retention of data and associated analyses after the study is complete (Huberman and Miles, 1994). The interactive cycle of data analysis activities includes processes for coding, clusters, and metaphors. These processes involve creating matrices for mapping concepts and identification of patterns and themes. Huberman and Miles (1994) described the data analysis process for qualitative studies as three interactive phases: data reduction, data display, and conclusions. Data reduction is the process of selecting, focusing, simplifying, abstracting,
and transforming raw information from field notes. This is a continuous process throughout the duration of the collection of data, not only at the end of the study. The interim on-going process includes coding, memos, clustering, and analysis as the data unfolds.

Data displays are often presented as narrative texts and unstructured. However, the most effective and rigorous devices are in formats of matrices, graphs, charts, and networks (Huberman & Miles, 1985). These devices influence a greater expectation for further analysis, grouping, and order. There is a greater emphasis for the researcher to consider all of the data, not only segments. The displays provide a structure to capture discoveries related to relationships, themes, and comparisons as illustrated in Figure 5. This dynamic framework is interactive throughout the data collection process, and critical to an in-depth analysis that leads to a rich in-depth summary of conclusions.

![Diagram of the interaction between data display and analytical text.]

Figure 5. Interaction between Data Display and Analytical Text (Huberman & Miles, 1994)

The final data analysis activity was conclusion-drawing and verification, an inductive process where the researcher identified relationships, patterns, and configurations, and begins to piece these data pieces together into data-encompassing units. The verification element to
this cycle modifies and supports the emerging themes and constructs related to the conclusions. This process is also dynamic, as the researcher may return to the displays and the data reduction to verify and revisit emergent themes and constructs.

Data collection was conducted by the researcher during the MJS program on 10 Saturdays during the months of January through April, 2014 on the campus of a research university in a mid-west metropolitan area. The instruments used for the data collection and analysis included observations of the learning environment, with the use of a documented process through the lens of the Effective Learning Environment Observation Tool (eleot), researcher notes recorded from focus group interviews, participant journal entries, video-recorded final presentations on the last day, and artifact review related to program materials and communications.

The researcher observed the learning environment of the MJS program through the lens of the AdvancED Effective Learning Observation Tool (eleot), which provided a method to capture participants’ engagement with activities and participant behaviors within the learning environment. Note-taking was the method used to document observations of the learning environment with the guided framework of the eleot. This instrument was selected based on the exclusive emphasis the learner-centric behaviors. The emphasis of the learner-centric model provided the researcher with a tool and guide for observing the experience of learners versus the quality and degree of instruction. The eleot was developed based on research from a variety of classroom observation instruments reflected in the work of Danielson (2007, 2009, 2011), Marzano (2001, 2007), and Pianta (2007).

**Focus group interviews-guiding questions.** The researcher established a set of questions used to guide the focus group interviews. The focus group interviews were
addressed during each Saturday session, and were spread across the 10 sessions of the program to have the least amount of intrusion on the time that the teams had to engage in the previously planned activities. Two teams were interviewed on each Saturday on a rotational basis. The researcher asked two to three questions during each focus group to cover the all of the questions. The questions included the following:

Describe what attracted you to participate in the MJS program?

Describe the previous experiences you have had in math and science activities, during and outside of school?

Talk with me about math and science classes that you have taken in the past and the classes you are currently taking in school?

What type of math and science classes would you like to take in high school? Why?

Describe what type of person is a scientist? Mathematician?

Describe what it means for you to be a “math person” or a “science person”?

Do you think you will take math and science in college? What courses?

What do you want to be when you grow up?

Describe the best/most important/exciting thing that you have learned at MJS?

What did you think about math and science before MJS? What do you think about math and science now?

Discuss the best thing/advantages and worst thing/disadvantages of participating in the MJS program.

**Participant journals.** Participants responded to the following prompts in their journals at the end of most Saturday sessions: Three things I learned; Two Wishes; and One Question. The researcher recorded the participants’ individual journal reflections by use of the note-taking method.
**Learning environment observations.** The environment has an influential impact on the development of identity. During this identity development phase, the formation of identity is primarily based on the feedback from the environment, and this influences individual self-reflections. Investigating the impact of the learning environment on girls’ motivation for science could help identify factors conducive to maintaining and sustaining girls’ interest (Spearman 2011). Researchers must carefully examine the stereotypes and biases that pervade the social context in order to understand the factors that will lead to balance in diversity regarding the STEM workforce. Encouraging more girls and women to enter these vital fields will require careful attention to the environment in our classrooms and workplaces and throughout our culture (Hill, Corbett, & Rose, 2010).

The AdvancED eleot observation framework differs from other instruments because the observer is focused on examining student behaviors and involvement versus the instructor, or adult at the front of the room. There are 30 items within the eleot tool that provide a format to the collection of data related to information about a student disposition and engagement in the learning environment. The overall reliability of the measure is .94 using Cronbach’s Alpha, which is considered a very strong level of reliability. In addition, confirmatory factor analysis of the root mean square error of approximation (RMSEA) as .066, which is also very good in social science research (AdvancED, 2014).

**Participant presentations.** The researcher used audio visual recording devices for the presentations of each MJS team during the final Saturday session. These presentations represented the focused work, research, and survey results created and analyzed by each team. The presentations were recorded and transcribed.
Document review. The researcher reviewed documents and artifacts related to the MJS program including the website, communication to participants and parents, information and surveys provided by the program for the participants and parents, program curriculum, daily activity plans, and artifacts provided during activities.

Data collection matrix. The researcher created a data collection matrix shown in Table 1 to frame the various types of data collection, triangulation of data sources, and the conceptual framework to capture STEM identity characteristics. The STEM identity characteristics are adapted from the prototype model for science identity developed by Carlone and Johnson (2007). This particular model was grounded during an ethnographic study of female college students of color in science programs; and as noted in Figure 1, this model provides an overlap of the science identity characteristics related to performance, recognition, and competence. This study refers to a STEM identity for seventh-grade African-American girls versus the science identity framework used for college female students of color enrolled in a science major as utilized by Carlone and Johnson (2007).
Table 1

*Data Collection Matrix. Methods for each criteria of developing a STEM identity*

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Recognition: Recognizing oneself and others as a STEM person</th>
<th>Performance: Social performances of relevant STEM practices</th>
<th>Competence: Knowledge and understanding of STEM content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews:</td>
<td>Influences that lead girls to the MJS program</td>
<td>Previous STEM experiences and accomplishments.</td>
<td>Levels of interest in STEM related to understanding STEM</td>
</tr>
<tr>
<td>Focus groups</td>
<td>Connection to being a math or science person.</td>
<td>Factors that motivate engagement and pursuit of higher level science and math experiences</td>
<td>Thoughts about the future and STEM aspirations.</td>
</tr>
<tr>
<td>Effective Learning</td>
<td>eleot: Interactions among girls within learning environments as measured by progress monitoring and feedback and supportive learning environment characteristics.</td>
<td>eleot: Engagement with high expectations, activity, equitable access, and use of digital tools. Group and/or individual presentations</td>
<td>eleot: Self reflections related to progress monitoring and feedback; and activity in the learning environment. Group and/or individual presentations</td>
</tr>
<tr>
<td>Environment</td>
<td>Journals Reflections</td>
<td>Program expectations and weekly objectives. Access and expectations to understanding STEM academic and workforce pathways.</td>
<td>Program expectations of individual knowledge and understanding of meeting program STEM expectations.</td>
</tr>
<tr>
<td>Observations (eleot™)</td>
<td>Program curriculum and activities Exposure to STEM practitioners in the workforce and academia.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Individual reflections about STEM activities</td>
<td>Individual reflections about connections to abilities and STEM</td>
<td></td>
</tr>
</tbody>
</table>

**Philosophical Assumptions**

The researcher adopted and identified the epistemological philosophical assumption for this research study. The researcher was immersed in the *field* and participated in all of the MJS sessions to understand the significant context of the program, and make inferences.
based on the experiences shared by the participants. The collection of data was based on the individual (journals) and group perspective (focus group interviews and eleot) about the experiences with the MJS program. The researcher constructed knowledge based on the subjective experiences of the participants in MJS.

**Ethical Considerations**

The measures to insure safety, confidentiality, and anonymity for human subjects included strict measures to protect the names of participants used in the research study. Pseudonyms have been used versus the participants’ names for anonymity. The researcher kept all of the data collection confined for the purposes of the study, and secured for privacy and discretion. Approval was granted by university’s committee on Research Involving Human Subjects prior to data collection for this research study.

**Validity and Reliability**

Validation in qualitative research refers to a process to assess the accuracy of the findings as described by the researcher. The strength of validation in qualitative research lies in extensive time spent in the field, detailed thick description, and the closeness of the researcher and the participants in the study. These factors add to the value of accuracy to the study (Creswell, 2013).

To provide validity to the findings for this study, the researcher used a rigorous data collection process involving multiple sources of data collection including interviews, observations, and artifacts as identified in the data matrix in Table 1. The interviews and observations required the researcher to be in the field with participants for the duration of the program, which included more than 60 hours, during 10 Saturday sessions.
The collection of multiple forms of data offer the opportunity for triangulation, that is a process of corroborating evidence from a variety of sources to record or document, code, and identify themes based on multiple forms of evidence (Merriam, 1988; Lincoln & Guba, 1985; Creswell, 2013).

Rich thick descriptions of the evidence collection using strong action verbs and quotes allowed for transferability and opportunities for connections (Merriam, 1988; Lincoln & Guba, 1985). Attention to details identified and interconnected general ideas to arrive at patterns and themes (Creswell, 1995). Reliability was established with the documentation of detailed notes, quality recording devices, and transcription of all recorded information (Creswell, 2013). Details of the learning environment and observations of participants’ activities were cited; thematic grouping and identification was employed to eliminate analytical bias, and to identify quotes and themes from the interviews. The researcher engaged in training and certification to ensure reliability and consistency with the use of the eleot™ framework for observations and note-taking regarding interactions and behaviors within the learning environment.

Methods used to conduct this study of female African-American seventh graders who participated in a science, technology, engineering, math (STEM) afterschool program, and the impact this experience has on developing a STEM identity included a qualitative approach to a phenomenological study. Data collection procedures described included observations with the use of the eleot as a lens to document participant engagement and interactions within the environment; interviews with guided questions; journal responses and reflections from participants; and document review related to the program.
Definition of Terms

**STEM** – the acronym related to academic and employment fields related to science, technology, engineering, and math. The terms *science* and *math* used together are directly related to the definition of STEM. The phrase *science and math* is interchangeable with the term STEM.

**Afterschool Programs** – refers to organized academic programs before the school day, after the school day, during weekends, during school breaks/holidays, and/or during the summer. Participation in an afterschool program is usually free and conducted on a voluntary basis. Afterschool programs are generally offered to disadvantaged students first and then opened to others, if room is available.

**Tracking** – the term used in this study to describe the practice of separating students according to ability level and/or based on teacher recommendations for placement in a specific course that determines access to higher level classes. Although the term *tracking* is no longer a popular term used to identify the practice, it is evident in an overwhelming number of schools. Tracking is used in 95% of middle and high schools in North America (Schweiker-Marra & Pula, 2005). Tracking may not determine the comprehensive identification of courses that a student takes outside of the specific course or subject area, however tracking determines a specific path and is commonly used for advanced math, science, and English placement and, moreover, begins a sequence for access to higher level courses in these subjects.
Chapter IV–Findings

The purpose of this descriptive qualitative study was to investigate the experiences and perspectives of seventh-grade African-American girls who participated in the Mae Jemison (MJS) STEM afterschool program. The following research questions guided this study:

**Research Question 1.** What influences African-American seventh-grade girls to select and engage in an afterschool experience related to STEM?

**Research Question 2.** What are the factors that may support, encourage, or motivate the African-American girls who participate in the MJS program to engage or pursue higher level science and math experiences, and courses that may lead to careers in STEM?

**Research Question 3.** What are the levels of interest in science and math for African-American girls before and after their participation in the MJS program?

**Research Question 4.** How does the learning environment support, encourage, or inspire the girls in STEM?

**Research Question 5.** How do African-American girls who participate in the MJS program identify with STEM as a part of building and creating their own personal identity?

This chapter includes the data findings and identified themes collected from focus group interviews, learning environment, and observations related to the research questions, and STEM identity characteristics as described through the lens of the science identity prototype model created by Carlone and Johnson (2007). The science identity prototype has been adapted to describe STEM identity for adolescent African-American girls, versus college-level women of color as in its original use. The theoretical concepts for this identity framework include recognition, competence, and performance, as illustrated in Figure 1.
This chapter concludes with the data collected about the MJS program and the impact on STEM identity for seventh-grade African-American girls. Pseudonyms have been created for the name of the program, subsidiary programs, and participants to protect the anonymity of participants.

The data for this qualitative study, with the use of a phenomenological approach, were collected on-site at a state university during a STEM afterschool program for at-risk girls. The MJS program included 10 Saturday sessions of 5.5 hours each during the months of January through April, 2014. The intent of the data collection process and analysis was to describe the experiences of African-American girls in the seventh grade and to explore identity development related to STEM as a result of engagement with the activities, lessons,
and field trips during the MJS program. The researcher attended all of the sessions for the MJS program with the participants, and two additional professional learning days with the mentors. Data were gathered by facilitating discussions and focus group interviews with participants, reviewing journal reflections and responses documented by the participants, observing the learning environment, and video recording final presentations made by participants on the last day of the program. Data gathering included note-taking and review of program materials, including the website; communications to participants; weekly lesson plans and daily activities.

The Effective Learning Observations Tool (eleot™) was used to document the conditions of the learning setting. The eleot is one of the tools used for accreditation purposes and continuous improvement for observing kindergarten through twelfth-grade classrooms. The purpose of the eleot is to identify observable evidence in classroom learning environments that are conducive to learning; and to conduct observations for creating the most optimal learning environments. The environments and items identified in the eleot are considered to be the conditions or setting in which optimal student learning occurs (AdvancED, 2012). The researcher was eleot-certified and trained to implement this tool for AdvancED accreditation external reviews and diagnostic reviews.

**Overview of STEM Program**

MJS was initially established to support and increase the competence, capacity, and confidence of middle school girls in the areas of mathematics, technology, scientific thinking, and communication, by engaging them in experiences that promote interest in and awareness of STEM related careers. The seventh-grade program integrates mathematics with social science research methods in a single sex, technology rich environment. The MJS
The MJS program was developed in response to the decline in mathematics interest and achievement among girls and minority youth during middle school (Reid & Roberts, 2006) and was designed to address the failure of girls to persist in mathematics and science. The elements used to accomplish the goals of the program have been shown effective in other settings—that is, single-sex participants (Haag, 1998; Lee & Marks, 1990), small learning groups (Peterson & Fennema, 1985), and role models and mentoring (Dubois, 2002; Freedman, 1993; Katayama, 2001; Sullivan, 1996). The implementation of the program provides training and support for the development of mathematics skills, scientific thinking, and career planning.

The strategies used for the MJS program have proven to increase female and minority students’ participation and achievement in mathematics, including small collaborative group work, and project-based curriculum related to students’ interests and experiences (Reid & Roberts, 2006). During the 10 Saturday enrichment program, the girls worked in research teams with two university student mentors enrolled in a Pre Student-Teaching course. Mentors were expected to guide the learning and engagement process for participants to explore a social issue, develop survey questions, analyze the survey results, and present the findings of the results to invited guests including family and friends.

During the MJS program the participants developed survey questions after learning about different types of survey questions, launched the survey via the internet, and used computer applications designed to develop data literacy skills for analyzing and interpreting
data. During the program the girls also toured the university campus including the research laboratories, learned how to access university library resources, met informally with female researchers, and participated in discussions related to career options. At the end of each Saturday session the girls wrote reflections in a journal about what they learned, questions they had about the day, and what they wished for. On the last day of the program each team presented their findings to a public audience of family and friends. Each team individually described their surveys, outlined the data collection process, and provided an illustration of the data results and analysis.

The MJS program provided an opportunity for the seventh-grade girls to participate in a project-based learning environment involving STEM skills and exploration. Each team used technology and online resources as they explored Inspire Data™; conducted online research; investigated a social issue; developed and launched a survey; and used scientific research-based methods and statistical applications to analyze the survey data. The team work approach encouraged the participants to work together. The participants solved problems as a team, created an original research question, and used data analysis skills to examine and interpret the data. The MJS program comprised four parts:

1. *Inquiring Minds.* During sessions 1–4, the participants explored scientific diagrams and charts and the topic *who we are* through a social science perspective. This work was the introduction to documenting and understanding data. Computer software, Inspire Data™, was used to apply data analysis skills; PowerPoint software was explored as a tool for presenting, and library skills of research, planning, and prediction were explored with use of PowerPoint web research.
2. *Survey Sleuths Surveys.* During session 5–7, participants were introduced to surveys and the scientific research methods used to investigate social issues. Participants acquired scientific vocabulary related to surveys and key terms, including stakeholders, research ethics, demographics, hypothesis, types of survey questions, and so on. Each team created a survey based on a social issue and launched it for responses.

3. *Amazing Analysts.* Session 8 was focused entirely on the examination of the survey responses and findings. Participants applied skills and understanding about surveys and data analysis as they inquired about the survey results.

4. *Whiz Kids.* During week 9, the participants created a PowerPoint presentation of the discoveries made from the survey results and used the scientific method to organize and present the findings of the survey results. On the last day, week 10, participants presented their social issue, survey results, and conclusions to the parents and public, which was mainly friends and family.

Funded by the National Science Foundation, private donors, and other STEM-related organizations, the MJS program was offered at no cost to participants. The program has served over 800 seventh-grade girls, and an average of 85% of the participants have been African Americans. The program has been replicated at five additional institutions; however, the site of this study has maintained the longest program that is integrated throughout the year for participation from each cohort.

**MJS Leadership and Mentors**

The 2014 MJS program was facilitated by three leaders from the university: an associate professor, who was also the director and co-founder of the program, an adjunct professor, who was also a middle school teacher, and a field experience coordinator. The
director of the program provided leadership and oversight for the MJS program design and activities, parent chats, and mentors in the pre-student teaching course. The adjunct professor was the main instructor for the mentors’ pre-teaching course, and supervisor for the implementation of MJS activities. The field experience coordinator evaluated the mentors’ role with the implementation and facilitation of MJS teams.

The MJS 2014 program was facilitated by mentors. In order to become a MJS mentor, college students applied for the role of mentor, and were selected for this pre-teaching experience based on specific criteria and qualifications. This unique program provided college students with immediate immersion in a classroom setting with seventh-grade girls in the role of mentor as teacher. In addition to the 10 Saturday sessions with MJS, mentors were required to attend a weekly evening theory class and three professional learning days.

Mentors received a mentor handbook, newsletter, course syllabus, and calendar. The mentor information also included the 10 full-day teaching opportunities with MJS, pre-student teaching field experience handbook, and MJS unit lesson plans and daily session goals. The lesson plans and Day at a Glance structure was provided for the mentors for the first eight MJS sessions, and were created in collaboration with the director of the program and the adjunct professor, who also supported the weekly evening teaching theory class. For the last two Saturdays of the program, the mentors created their own lessons, and this work was evaluated by the adjunct professor and the field experience coordinator.

The 2014 MJS program included 11 female mentors. Eight of those, (72.72%) were STEM majors, two (18%) were majors in English language arts, one (9%) in special education, and one (9%) in foreign language. Eighty-eight percent had experience at the middle school level, 27.2% were enrolled in the master’s degree, and 72.7% were
undergraduates in teacher education programs. In addition, 4-5 university students supported
the program each Saturday as volunteers and provided assistance to the mentors in the team
setting. The researcher documented the race of the mentors; six women of color, and five
white.
The mentors worked in pairs to facilitate the curriculum and program activities. These
partnerships were self-selected after the mentors were involved a full day of professional
learning and an evening class, including activities such as Personality BINGO and All About
Us Venn diagrams. The criteria for partner selection was to find someone with different
strengths.

The first professional learning day for the mentors at the MJS site was a full-day
introduction to the course and the mentorship program for the facilitation of MJS. In addition
to the pre-student teaching overview, deliberate community-building activities mirrored
similar activities that would be facilitated for the MJS participants, including Personality
BINGO, and All About Us Venn Diagrams. The following topics were also covered to
prepare the mentors for the MJS participants:

- Gender myths about math and science and the fundamental goal of the program to
debunk the myths!
- Math and science does not need to be a strength, however awareness of
  language… capable, competent, and able to persist!
- Course Syllabus – Emphasis on professionalism, communication with parents,
  attendance, logistics of the facility and classrooms, and the Teaching Guide.
- Modeling activities, emphasis on scientific terms, human graphing, group
  facilitation skills, and learner engagement.
Parent Involvement

**Participant and parent orientation.** There was an expectation for parents to be involved in supporting the MJS participants. The first activity for parents was to participate in the orientation for both parents and participants. The parent and participant orientation for the MJS program occurred one week prior to the first session of the MJS program for participants. The orientation was an introductory meeting and provided an overview of the program, including the schedule, activities, and field trips. Additional information was shared about girls in STEM, the significance of math and sciences in kindergarten through 12th-grade experiences and college and career statistics about girls in STEM. Parents completed permission slips, agreements for expectations of the program, and received additional materials about the program. Parents were asked to agree to a strict attendance policy in order for participants to receive a certificate for program completion.

The researcher attended the orientation for parents and participants and provided information about this research study. Consent forms were provided to parents, participants, and mentors (See Appendix B). The text for the researcher’s introduction to the study, and overview of the consent forms may be found in the (See Appendix C).

**Parent chats.** In 2009, parent chats were introduced to provide education and outreach to the parents of participants. Morning sessions allowed parents to engage in learning about the program and provided future opportunities for the participants to continue to stay connected with the program and gain college scholarship awareness. More than 200 parents have attended the chats.

During the MJS 2014 cohort, three parent chats provided information to parents and an opportunity for discussion about career awareness, college readiness, including high
school course work and scholarships, and online resources for research and safe social media practices for youth.

**Overview of Participants - 2014 Cohort**

The MJS program recruited seventh-grade girls in the inner city and metropolitan area of a major metropolitan city. Program information was also provided to other science and math afterschool programs that served middle school students. The process for enrolling in the program included an online application, followed by a selection process. More than 120 participant applications were received for the 2014 MJS program, with only 60 seats available. Seventy girls were accepted in the program, with the understanding that there would be some attrition from the original group before the program began. Prior to the first day of the program, eight participants chose not to participate and withdrew.

Thus, the 2014 MJS cohort included 62 participants. Of those, 55 (88.7%) provided parent and participant consent to be a part of the study. The participants’ ages ranged between 11 and 13 years; all were in the seventh grade, and attended 50 different metropolitan-area middle schools. The racial demographics included 85% African American, 7% Latino or Hispanic, 5% White or Caucasian, 1% Asian, 1% Native American, and 1% preferred not to answer. The average daily attendance rate for the program ranged from 80 to 95%, with an average of 91% average daily attendance rate for the participants in the study.

**Data Collection**

Focus group interviews were facilitated by the researcher during the MJS Saturday sessions of the program. During the focus group interviews the researcher visited each team in the assigned work room or technology lab, and three teams rotated each week for a 15-20 minute team interview with the researcher. In each focus group interview, the researcher
introduced the topic and then prompted one to two questions. There were very few follow up questions due to specific timeframes set aside for the focus groups and the number of participants on each team, which ranged from 8 to 11. Appendix D provides the focus group interview questions, sessions, and teams.

The participants sat in a circle during each focus group and responded to the questions proposed by the researcher. The participants sat at rectangular tables in a few of the focus group interviews which met at the end of the lunch period in the cafeteria. After the 3rd and 4th focus group interviews, and as time progressed, the participants became familiar with one another and moved from responding directly to the prompted questions, to engagement with one another as the dialog related to common interests expressed during the focus group sessions.

The researcher observed the learning environment during each session using the eLeot as a guide to document the engagement and learning conditions within the environment based on interactions and participation of participants. The researcher also reviewed individual journal responses and video recorded the final presentations on the last day of the program.

**MJS Program-On-site**

A regular routine for the MJS program began on the first Saturday morning of the 2014 MJS program, a cold and snowy day in January. The mentors bundled up to welcome the participants at the drop off location each Saturday morning with colorful signs that included the program name and a multicultural image of stylish girls interested in STEM. Each mentor waited for a group of seven to ten girls to arrive, then walked with them across the campus to the MJS program, which was facilitated in a wing on the ground level of the
College of Education building. The reserved section included four classrooms, and two computer labs as well as a larger room on the lower level reserved for the orientation and *parent chat* meetings.

On the first day, the majority of participants arrived without knowing any other girls. Only three of the 50 schools from which participants came had multiple participants. As the girls entered the MJS space, they quietly moved to the largest room as one group. The girls appeared somewhat reserved and a little nervous about starting something new in an unfamiliar environment with other girls that they did not know. There was also a quiet sense of attentiveness, eagerness, and excitement, as the girls listened closely to the program curriculum, syllabus, overview, and expectations. The participants were reminded that although 70 of 120 applicants were accepted, 62 attended and participated in the program. Camille described her experience of being accepted into the program. “I was nervous about getting in. You have to be selected, so I was excited about getting in.” Erin was also very keen about being a part of MJS, “I kept checking email to see if I got in. I was nervous because I did not know if I would get in.”

After the initial welcome, the girls were assigned to teams and divided into six groups. Each team had 9 to 12 participants, two mentors, and additional volunteers who rotated among the teams. The teams worked in pairs, with two teams in each room. The first day started with a community builder within the teams. Using scientific charts to get to know one another, the teams used the Venn diagram to discuss their similarities and differences and practiced interpretation skills based on a chart.

Each MJS morning session started with the entire group in a room for the first 20-30 minutes and a community builder that supported the girls’ efforts to get to know one another
using an element of STEM. After the community builder opening activity, the participants moved to assigned rooms and worked as a team or were paired up with another team to engage in the curriculum and activities for the day. At lunch, participants expressed enthusiasm about eating college food in the university cafeteria, and at the end of each day, the mentors and participants walked back to the morning drop off location for the participants’ ride home.

The 2014 MJS program attracted almost twice as many applications as there were spaces available for participation in the program. MJS was promoted by individual testimony from family and friends, online advertising on the MJS website, and social media; other schools’ STEM-related programs also provided information about MJS. The description of the program highlighted the single gender environment with seventh-grade girls, and experience for highly talented at-risk girls. The description focused on activities and opportunities to explore STEM and related careers. The information stated that the 10-week Saturday program was scheduled from 9:00 a.m. to 2:30 p.m. during the months of January to April on a state university campus in a Midwest metropolitan community and emphasized that the program was offered at no cost for the participants.

**Findings Related to the Research Questions**

**Research question 1:** What influences African-American seventh-grade girls to select and engage in MJS (an afterschool experience related to STEM)?

During the first and second Saturday sessions of MJS program, the researcher engaged the participants in focus groups to explore what led or inspired them to be a part of the program, and to identify the influences that may have supported their decision to attend. The participants identified external influences that provided the initial information about MJS
including parents and family (38%), school (33%), previous MJS participants (6%), and other programs (4%). However, 19% of the participants identified their own interest as the motivation for acquiring information about the program.

Based on the six focus group sessions, three themes emerged regarding the influences and motivation for participant enrollment in the MJS program: a sense of belonging and being with other girls; interest in STEM and a desire to learn or try something new; and overcoming obstacles.

**Theme 1—Sense of belonging and being with other girls.** A prominent theme that emerged from the focus group discussions about what attracted the participants to the program involved building relationships. Thirty-six percent of the participants mentioned being with or learning with girls and meeting new friends as a part of the motivation for participating in the program. However, this sense of connection to other girls in the same grade was most often connected to an area of STEM as well as learning with other girls. Jennifer stated the following as she reflected on her decision to join the MJS program. “I like it that this is for all girls. I was on the robotics team, and it was all guys. My mom told me I would be with girls my own age… and this will help me because I want to be a neurologist (when I grow up).” Participants also mentioned building new friendships and the potential for learning more about math and science. Karen highlighted making new friends and learning. “I wanted to meet new friends and get ahead with some math and science things.”

Prior to attending the program most of the participants were looking forward to the exploration of STEM, and being with other girls their own age. The following is a sample of statements made by participants that linked learning with other girls and learning about STEM as motivation to participate in the MJS program:
“I am interested in being with other girls, and I like science and math very much.”

“I really like math and science, and I want to be a better presenter and have more social skills.”

“I like math and science…and want to meet new people.”

“I wanted to meet new girls.”

“(I am) glad it's seventh-grade girls only! I do not like older girls.”

“I am interested in being with other girls.”

The learning together theme emerged in the beginning stages of the focus group interviews and resurfaced during interviews at a later time when the reflections from the participants described the strengths and challenges of the program.

**Theme 2 – Interest in STEM subjects.** An interest in science, math, or other related subjects within STEM disciplines was the second theme related to the influences that led to participation in the MJS program. More than 40% of the participants identified an interest in a future STEM-related career. Whereas others that did not identify a STEM career, a few identified the potential need for math and science in order to achieve their career goals. For example, Nedra stated that she wants to be a fashion designer, and made a direct connection to her broad interest as a designer, and the skills necessary, “… I want to be a fashion designer, and I know I need math for that”!

Participants referred to the following topics when describing a level of interest in STEM and the selection of the MJS program: career choices (40%), math and science subjects in school (25%), an interest in learning something new about math and science (11%), and electronic gaming and a love for computers (9%).
Career Interest: “I want to know more about science, and it is a part of my life because I want to be a nurse like my grandma. I need to know math for this also.”

School Interest: “I’m really good at math, top of the class! Top of the class in science too! We are doing chemistry with the periodic table.”

Science! I like to do experiments.

Gaming: Sandra’s voice became an octave higher, and her eyes widened with enthusiasm as she described her interest in gaming and technology. “I love video games and computers! I made a server to build stuff, and you have to know how to multiply measure and figure things out. When you are building you have to know what quantity you need and the materials.” Andrea identified why she likes electronic games and computers, “I’m not really good at math, but I like video games and figuring out what goes where and how.”

**Theme 3—Overcoming obstacles.** More than 22% of the participants identified a challenge as one of the reasons for joining the program. The challenges were self-identified and included struggles specific to academic math and science concepts and information learned in school, a need for help in overall academics, and challenges related to boredom or not being challenged enough at school. The participants who acknowledged an area of weakness towards math and science also vocalized a willingness to engage in what the program had to offer as a way to improve math and science skills. Several of the statements provided by participants included the possibility that this experience could help them in math and science and overall at school.

Grace: “I struggle in math and science, maybe this could help.”

Joan: “I struggle in math and science, maybe this could help me. It looked interesting when I went online to look at it.”
Janet: “I wanted to be in something that would help me in my academics.”

On the other hand, some participants were in the program to challenge themselves due to boredom and a desire to learn more about what was being taught at school.

Barbara: “I do not find science challenging enough at school. I like it, but I’m bored.”

Zena: “I moved and I was transferred to a new school. They are trying to find things for me to do since I am ahead of my class, and it is not a challenge. Maybe this will help.”

**Research question 2:** What are the factors that may support, encourage, or motivate the African-American girls who participate in the MJS program to engage in or pursue higher level science and math experiences and courses that may lead to careers in STEM?

During the focus group interviews the participants identified potential STEM high school and college courses that they would like to take and also described the reasons and motivation for taking these courses. Three major themes emerged from the discussions about the participants’ experiences related to motivation to engage or pursue higher level STEM courses that may lead to careers in STEM: Interest and desire to learn more about STEM (29%), Challenge (21%), and Future goals and plans for career and college (37%). The majority of participants (75%) described school math and science experiences as the primary venue for exposure to STEM activities. Computers, video games, other afterschool programs, and the internet was mentioned by 10% of participants as activities outside of school where they were engaged with STEM.

The participants’ involvement in math and science classes at school ranged from general and basic to advanced levels. Approximately half (49%) of the participants were enrolled in general or basic math classes, and 51% were in advanced math classes such as pre-algebra and algebra. However, in science courses, 58% were engaged in general science
classes, 20% in honors or advanced science, and 10% in specialized science classes, such as Earth Science, Physical Science, and Chemistry, and 12% in other related science courses.

The participants were prompted to share whether they were planning to take higher level STEM classes in high school or college, and the reason for these choices. For high school, 33% of the participants identified advanced math classes such as trigonometry and calculus. High school advanced science classes were also identified by 33% of participants. The participants who identified advanced math and science courses for high school were motivated by enrolling in a challenging course to expand knowledge related to STEM (22%), a fascination with math and science courses (29%), and future plans for STEM related careers (37%).

Eighty-three percent of participants stated that they will be taking college STEM courses such as math, science, engineering, and computers. More than half of the participants (52.7%) indicated that the major themes for STEM college courses were specifically related to future college and career goals of participants, and 22% of participants chose those courses to meet their interest and desire to learn new things about STEM.

**Theme 1‒Interest and desire to learn new things about STEM.** For many participants, the appeal for advanced STEM classes and related course work was an internal initiative connected to an individual effort and desire to learn more about STEM, or a passion for STEM related topics and activities, particularly in the areas of math and sciences. The interests and motivation for high school course selection were mainly identified due to the enjoyment for the subject, and a desire to learn more about a particular part of a STEM.
Mae: “I would like to take these (higher level) classes because I love chemistry, and different explosives.” Jennifer responded, “Me too! I would like to take chemistry because I like mixing things, and I also like seeing things that explode”!

The participants understood that there are a variety of courses and subjects within the STEM arena and identified choices and a wide scope of topics as a part of their interest in specific areas related to STEM. Sandra described her interest in algebra and biology to support her choices to take these courses. “I want to take advanced math…because I like learning formulas in algebra. I would want to take biology… because I hate chemistry and this is the only other choice. Also, I like plants and animals.” Corine’s choices came together as she described her interest in astronomy. “They (advanced science and math classes) seem like interesting classes and they all involve things I like, especially astronomy.”

Participants identified strengths as a way to validate choices and levels of interest in meeting higher level expectations in advanced STEM classes. Michelle and Averie captured this idea in the following quotes:

“I like science because of the experiments and math (we did) graphing and properties, and academic games is [sic] fun.”

“I love the reactions in science!”

“I like advanced math because you learn bigger problems.”

“I would take an advanced math class because I'm advanced in math.”

“I would take a science class that does experiments because I would like to see things explode or get bigger.”

“I will take an advanced math class and a regular science class that does a lot of experiments.”
Theme 2—Challenge. The second theme related to motivation and interest in taking higher level STEM classes included taking on a challenge and an opportunity to expand and increase knowledge in these subjects. However, there were also specific references to current classroom activities or STEM subjects in school that were boring and that challenge may increase interest and application in the advanced classes.

“I would like to take all AP classes because being in regular classes would be very boring. They're (advanced STEM classes) interesting and might help me in the future...math is not my strongest subject, and science is kind a boring.”

Participants (22%) identified the need for a challenge and expressed excitement about the opportunity to expand their intelligence in these areas when considering the challenge of taking advanced coursework in STEM subjects.

“I would like to take these classes because I am a very advanced student and I like a challenge. I am very smart and I like to show it. I also want to be a marine biologist when I grow up.”

“...because if I took these (advanced level) classes, I could get smarter and have more fun with each new challenging class.”

“I would like to take these classes because they will push and motivate you to pass the class. These classes would also challenge you in high school.”

“To challenge myself and take my knowledge to great heights.”

“I would like to take these classes for a few reasons. First, it would be a challenge that would help expand my knowledge in these subjects. It would also look good on a college application.”
**Theme 3 Future–Career and College.** The third theme that emerged related to the reasons why participants may engage in the pursuit of advanced levels in STEM high school and college classes was based on their future aspirations related to relevant college and career preparations. More than 50% of the participants identified career or college goals as the significant factor for advanced STEM courses in college, including careers that may seem unrelated to STEM. Advanced high school course selections in STEM were identified as a way to reach career and college pathways. Many of the participants expressed a desire to attend college, and there was an understanding that STEM related subjects would support the groundwork as a part of the planning process to enter the college level.

“I want to take more math and science classes to learn more and prepare for college.”

“This (advanced math and science classes) will help me have background knowledge for college.”

“I want to get into a University. I know that math and science classes are some of the most valuable classes. I really enjoy math and science.”

“I would like to take these classes for a few reasons. First, it would be a challenge that would help expand my knowledge in these subjects. It would also look good on a college application.”

Specific career pathways were also identified as an impetus to pursue higher level STEM related courses.

“I will take the advanced math courses and also study marine biology. To be a marine biologist, I need a master's degree in marine biology. I also need to be good at math. I will need these classes to be a marine biologist in the future.”
“I want to take a medical science class because I want to learn about it and it seems very interesting. Also, I want to be a neonatal doctor when I grow up so this would give me experience. I know in order to be a neonatal doctor, I would have to take a math class but I don't know what.”

Although there were participants who did not want to major in STEM careers, there was an understanding that STEM is interrelated and may support many different types of career and college pathways. One participant proclaimed that she would like to be a fashion designer and recognized that although this is not a STEM related career there was the realization that STEM skills are needed to be a successful fashion designer “I want to take computers and advanced math courses… because I think that I need algebra to be a fashion designer.”

**Research question 3: What are the levels of interest in science and math for African-American girls before and after their participation in the MJS program?**

Participants had various levels of interest and experiences previous to the MJS program. Some of the participants entered the MJS program with a ready interest in STEM activities and academic pursuits related to science and math. STEM professions such as teacher of math or science involving health sciences, biology, chemistry, engineering, and education were identified by 52.7% of the participants as career goals and future aspirations. All of the participants were able to identify experiences and involvement in STEM activities with engagement in either school, afterschool programs, or electronic games and technology explored at home. Experiences related to school or afterschool programs were described with varying degrees of interest, appeal, or attraction. Some of the participants (23.6%) had additional out of school activity experiences. Sandra: “I went to an afterschool program…

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and we made kites. We measured angles and wind; we also made rockets.” Catie: “I did a science and engineering program… It was for one day. We built a bridge and learned about the process of engineering and the science behind it.”

Overall, 76% of participants identified an increased level of interest in STEM at the end of the MJS program. The following themes emerged related to the participants’ levels of interest, prior to and after the program: Comparison of school subjects and MJS, transfer of skills in school; real Life; and STEM content. Although these themes are discussed separately, there is overlap within each concept, and one participant’s comments summarize all of these themes as a part of the participant’s reflections on her experience and interest in the program.

“I thought it was positive (experience at MJS), and I enjoyed using math and science in the real world application, not just lectures at school. I also liked working in a team to create graphs and a survey because the information was easier to find working together.”

**Theme 1–School Experiences with STEM.** The participants’ interest in math and science subjects at school was enhanced by the MJS program. Many of the responses regarding what participants thought about STEM before and after the program evoked a comparison of what it is like to learn about STEM in math and science classes as compared to the experience at MJS. The greater majority (76%) identified an increased interest in STEM.

(Before MJS) “they seemed like regular subjects, now they are a lot more important and I want to go further and learn more and read things on my own.”
(Before MJS) “science was my favorite and math was my least favorite. Now in MJS, I like Math. It is a more fun way to do it. When I am in math at school I imagine how it would be in MJS and then it is more fun, and I like it a lot more.”

“I guess science has changed, because it is more than memorization. We do stuff that is hands on…not like school and memorization. Now there are more ways to look at it, like the graphs and (social) issues.”

“In science there are new topics that I know, and in school we are talking about the body… and how can foods affect the body. I got extra credit because I explained what I learned about…and how food can make you sick or better… I learned new things to help at school.”

“When I first started, I did not like math; now I like it and I feel more comfortable and I understand it better. This has made it better in school.”

“Before, I was not as good at math, and it was least strong. Science was my favorite now I am involved in math more and I am understanding story problems, cuz those are given on tests.”

“I hated math before; now I like it and I am doing better… I am going to take the advanced class next year.”

“Before, I liked science better than math. I am good at both. Now I have a deeper understanding. At school we talked about surveys and I already knew about the open and closed questions, because I learned that first at MJS”

**Theme 2—Real life.** Participants were eager to discuss the concepts related to how real life is connected to STEM and how real life application of STEM may lead to additional learning interests and increased opportunities for success. The connections to real life
fascinated the MJS participants and led to a desire to learn more. More than 25% of participants identified that they learned how math and science work together and the relationship of those topics to real life.

“Before MJS I really liked math and science. My skills have not changed but how I look at it (science and math) has changed, and how I learn and how it applied to my life. I want to learn more (about STEM)!”

“I liked math before and now I like it even more because the survey shows how science and math are different and alike; and there are different ways to look at math problems if you think about different things in life.”

“I liked math and science; now I see how it applies to my life.”

“At MJS I learned that science is more interesting, and I realize that MJS has taught me new things about life like the food desert, and I have talked about this with my friends.”

“It did not occur to me how important science and math are. I need it to be more successful in my life. There are different types like physics, and I would like to learn more about it. I know that math and science go together.”

**Theme 3–Increase in STEM content.** The majority of participants identified an increase in STEM-related knowledge and skills that related to STEM topics such as survey analysis, social science issues, charts and graphs, data software, PowerPoint as a tool for presentations, and speaking skills for presentations. At the end of the program and during the sessions, 9 of 10 participants easily made connections to STEM content-related skills and knowledge acquired from the experiences and engagement with the MJS program activities.
“The MJS program helped me in math by making all sorts of surveys.”
“I liked the different activities, I liked making the survey, and I like how I love math and science more!”
“I like science more and, in math, I understand graphs better. I appreciate science more because we do a lot of hands on stuff (at MJS) and not at school.”
“Before, I like math not science. Now, I enjoy science more because it is hands-on, and we experience different places like the South Market and using Inspire Data.”
“Now there are more ways to look at it (STEM), like the graphs and the food desert.”
“I get the analysis questions, and I experienced it more because of the writing after class.”

A small percentage of participants (7%) identified no difference in STEM interest after the MJS program. Participants compared the MJS STEM experience with math and science course work at school. Some of these participants began the program with an interest and experienced no change for example, Janet stated, “(Before), math and science were easy and my favorite… still easy and nothing new.” Carla indicated that “math is the same; I still feel confident about math. I am still doing good.” Few participants entered the program with low interest and left the program with the same low interest.
Research question 4: How does the Learning Environment support, encourage, or inspire the girls in STEM?

Setting of the Learning Environment

A state university campus in the Midwest was the setting for the MJS program, which was facilitated in five rooms including three College of Education classrooms, and two computer labs on the ground floor of the building. Upon entering, the participants noticed pictures of previous college deans on a plain wall; however, as they entered the main hallway that connected the three MJS participant rooms, the walls came alive with a display case decorated with the MJS program logo, paraphernalia with the logo, and pictures of previous cohort participants.

Each room used for the program had unique characteristics with a variety of size, décor, and furniture. The teams were assigned different rooms for each Saturday session and rotated during the day for different activities. The big room was a large open space with college style individual desks and chairs that could easily be moved for the morning community-builder activity. The comfy chair room had large, soft comfortable chairs and large tables in horizontal rows that remained in place and the small room was equipped with mobile individual chairs attached to a desk top.

Each Saturday morning, the participants’ day began in the big room where the mentors facilitated a different community-builder activity for the participants. The big room had a colorful bulletin board with a list of careers in STEM and other professions that required higher level math and science courses, including medical doctors, nurses, chemists, teachers, real estate agents, fashion designers, and so on.
The comfy chair room, the largest of the rooms, had the capacity to include all of the girls seated at long tables and comfortable chairs; two walls were covered with white boards. Two sets of mobile Apple laptop computers were often used in this room with one or two teams of participants.

The smallest of the rooms, appropriately called the small room, was about the size of a regular school classroom, with approximately 22 college-style desk and attached chairs and a white board at the front of the room. Two teams could work in this room and would often use the additional computer labs for the research, and inquiry-based discovery and exploration for the survey work with Inspire Data™.

The effective learning environments observation tool™ (eleot™). The researcher observed the learning environment with the Effective Learning Environments Observation Tool™ (eleot™), which was created and developed by AdvancED (2012) as a means to conduct observations for creating the most optimal learning environments in which students can learn. The eleot differs from other observation instruments because it is a learner-centric tool that guides the observer’s attention to individual and group interactions, involvement with curricular activities, engagement with digital devices, and the attitudes and experience of participants within the context of the physical and conceptual learning environment (AdvancED, 2014).

The researcher is a certified Lead Evaluator for the AdvancED process and trained to implement the eleot for accreditation and diagnostic reviews for school and systems and to measure levels of engagement within the classroom setting for continuous improvement. The purpose and use of the eleot in the MJS setting was to identify observable evidence in learning environments that are conducive to learning, and to observe participant engagement.
The learning environment observations focused on examining participant behaviors and dispositions versus the instructor, or mentor at the front of the room. The researcher documented data from the learning environment with the eleo tool for a total of approximately 20 hours over nine MJS full-day sessions. One to all six teams could be present for the observation, and the team combinations rotated each week.

The learning environment observation tool (eleot) included 30 items that provided a format for the collection of data about the participants’ experience and engagement in the learning environment. The scale for rating the items that support each learning environment ranged from 1 to 4, where 1 = not evident and 4 = very evident. This scale provided a perspective about the participants’ validation and expression of the items within each learning environment. Using the eleot, the researcher observed the teams in each room for 20 to 35 minutes during nine out of ten of the sessions. Seven learning environments were observed:

A. Equitable Learning Environment
B. High Expectations Environment
C. Supportive Learning Environment
D. Active Learning Environment
E. Progress Monitoring and Feedback Environment
F. Well Managed Learning Environment
G. Digital Learning Environment

Learning environments ranked showed a score of 3.2 for well-managed to 2.4 for equitable learning and digital learning, as illustrated in Figure 4.
Equitable learning environment—eleot rating: 2.4. The participants expressed and demonstrated learning in different ways and communicated this new knowledge through different methods and approaches. Participants used the white boards during activities to represent various charts and graphs, participants worked individually, in pairs and groups while accomplishing tasks that were academic-based with research and survey development. Participants verbalized and documented learning in discussions, on assignments, and in the individual journals. Participants used webquest, worked in partners, groups, and provided feedback to other teams after surveys were completed and before it was publicly launched.

Participants used technology and online resources. There were opportunities for engagement to learn about one another during the community builder activities each morning in the large group with all participants. One participant described the community builder, “Playing the games in the morning is super fun! You get to express who you are. Today, (a mentor) asked us questions. If the question applied to you, you stood in the middle for a
second and walked out. She asked some personal questions.” Another participant stated, “I loved learning about the other girls in MJS in the morning”!

**High expectations environment—elevot Rating: 2.9.** Participants were introduced to the overall expectations at the first Saturday session; thereafter, each session started off with the expectations for the day. Activities and groups were challenging to most participants, and they worked to perform each task and activity as the expectations illustrated. Participants were engaged in statistical analysis skills through a process of engagement with activities and assignments that encouraged and inspired probing questions.

Participants researched and explored a social issue and created a survey for stakeholders. This process included defining and identifying stakeholders and reviewing a variety of sample survey questions to develop and create an original survey related a social issue for a specific stakeholder group. Participants used specific vocabulary regarding the context for the social issue, and applied the knowledge from exemplars to launch a valid survey to evaluate the results.

**Supportive learning environment—eleot rating: 2.8.** As the sessions of MJS progressed, the participants entered the MJS site with eagerness and excitement. Participants often greeted one another with a smile and, during the learning activities and assignments, participants asked keen questions and were willing to try something new, including the exploration of a social issue (such as the food desert) and data analysis with unfamiliar computer software. During the introduction to these topics, the participants demonstrated supportive behaviors such as asking questions about the unknown, taking risks, and being helpful to one another.
**Active learning environment – eleot rating: 3.0.** The participants were involved and engaged in high levels of participation with a variety of individual, small group, and partnered activities and discussions. There was great enthusiasm as the participants explored a challenging *Mission Possible* activity in pairs and while investigating Inspire Data online. The contributions of each pair and group discussion unfolded the mission and brought together the pieces of a puzzle, while the participants acquired skills in data analysis that would be transferred to the final survey project. Participants also completed a group scavenger hunt at a local market and discovered the university campus and STEM buildings. The researcher observed high levels of engagement in active learning as the participants found their way to complete activities and respond to the challenges provided.

**Progress monitoring and feedback environment – eleot rating: 2.7.** During the MJS, it was evident that the participants were engaged in the daily activities, and asked clarifying questions to fully apply themselves to the expectations. Most often participants responded to questions with answers to support verification of accuracy as a follow-up to what was already shared by the mentors. The evaluation of this knowledge and understanding was conducted through informal verbal assessments and the completion of specific tasks and projects. However, it was not always evident that the participants were clear about how they would be evaluated because the learning objectives were on-going, and students were not receiving a grade for the work. Instead, participants were focused on completing and understanding the task rather than a final assessment and evaluation from the mentors.

**Well managed learning environment – eleot rating: 3.2.** On the first day of MJS the participants were somewhat reserved because most of them did not know one another. At the same time, however, they were attentive and curious about what was ahead for them for the
program. They listened as the mentors provided an overview of the program syllabus and expectations for the program. As reinforcement, the teams engaged in a game of competitive Jeopardy, based on questions about the syllabus and expectations for the program. This activity set the stage for participants to ask questions about expectations and to become familiar with the norms established.

During the course of the program, the participants became familiar with one another, upheld expectations, and engaged in a high level of respect for one another by listening to peers and the mentors and following directions provided by the mentors. As the sessions progressed, the participants asserted themselves by asking specific questions and vocalizing validation of shared ideas within the team setting.

**Digital learning environment—eleot rating: 2.4.** The participants were engaged with technology to research topics, review surveys, and explore statistical data analysis with the use of data software. They also used the technology to create an original survey and launch the survey online. After the survey was launched, each team analyzed the data by creating different types of charts and graphs to share findings during the final presentation.

Due to the rotation of the researcher’s observations, and that the teams were often working with technology at the same time, the researcher noted the eleot as one of the lower ratings of the learning environment. However, the engagement of participants and the continuation of learning was relevant to the work that participants were engaged in online. Also, as noted by participants in individual journals and feedback regarding overall learning, working with technology had an impact on learning activities. More than 70% of participants indicated that the digital learning components provided the greatest area of learning, particularly in exploration of different types of surveys, creation of a survey, data retrieved
from surveys, Inspire Data investigation, and *mission impossible*. The digital learning environment extended toward integration throughout the learning process and was relevant to the final project and presentation.

**Research question 5:** *How do the African-American girls who participate in the MJS program identify with STEM as a part of building and creating their own personal identity?*

The researcher used the science identity prototype by Carlone and Johnson (2007) to address the research question. Carlone and Johnson’s original science identity model was designed to understand the science experiences of women of color during undergraduate and graduate course work in science and science-related careers. The longitudinal study included follow up interviews six years after the initial data collection.

The science identity prototype designed for the study of college women of color was adapted by the researcher for this study to support the understanding of STEM identity development for adolescent African-American girls engaged in the MJS program. The identity framework includes three concepts: recognition, competence, and performance (See Figure 1).

Themes related to each identity component emerged. Recognition - Recognizing oneself, and getting recognized by others as a science person; Competence - Knowledge and understanding of STEM content, may be less publically visible than performance; and Performance – Social Performances of relevant scientific practices, for example ways of talking and using tools Carlone & Johnson (2007).

**STEM Identity Component 1—Recognition.** Participants demonstrated recognition of oneself, and recognized by others as a STEM person during the MJS program. Participants identified both internal and external influences for recognition as a STEM person. Most of
the participants described themselves as a STEM person and made connections to their own individual enjoyment and achievements in science and math at school, afterschool programs, and at home. Personality characteristics related to STEM skills and dispositions were also defined in support of what makes a STEM person. Participants also described external acknowledgements such received from teachers, grades in school, family members, and out of school experiences as a part of being recognized as a STEM person.

During focus group interviews participants identified internal and external distinguishing factors related to recognition. Participants indicated that they were encouraged to attend MJS by parents (38%), school (34.5%), friends, and other programs (7.5%) and also indicated that it was their own self-interest in STEM that led them to be a part of the MJS program (20%).

**Recognition internal themes.** “I like it!” “I have STEM skills!” “I have the personality for STEM!” During focus group interviews the participants were quick to define their involvement with STEM, starting with the levels of interest related to affective experiences and interpretation of success in math or science. Participants identified whether they were a math or science person and described whether they enjoyed the subject.

“I pay attention to things, I love science!”

“I like to imagine things, like purple and black together, and periodic tables, gamma rays, and other effects.”

“I am more of a math person than science. I like math because I excel at it. It is a topic of logic and everyone can be logical. In my spare time I like to do it too!”

“I am more of a math person. I like figuring things out.”
Sixty-five percent (65.4%) of participants identified something that they like about STEM and linked that to what makes them a science or math person. These comments comprised feelings of enjoyment and success and connections to STEM skills such as algebraic problem-solving, hands-on experiments, chemistry, biology, figuring out how things work, scientific formulas, and so on. Fewer participants (5.4 %) indicated that they did not like science; however, they liked math; and 18% of participants indicated that they did not like math, but liked science.

Participants also described their personalities, or traits that impact the work and skills of a STEM person and claimed these characteristics as their own. One of five (20%) indicated that they have personality traits that complement their self-recognition of STEM, including characteristics such as intelligence, discoverer, curious, open-minded, organized, explorer, and patience. As the participants reflected on how they view themselves as a STEM person, there was an eagerness to share their interest, and association with how this is a part of who they are as an individual.

“I am a smart person and I like to explore new things. I am not patient, but I’m open-minded. I like grey, not black and white.”

“I am organized and it (STEM) is fun!”

“STEM is related to being curious and a good problem-solver, and I am both!”

“I am a math person. I think that math is simpler than science. There is only one answer in math and lots of answers in science.”

“I like to discover new things…”

“I love to figure things out, and I am curious.”
Participants also described their future goals as internal recognition of themselves having an affiliation with an individual STEM identity. Four of ten (40%) of the MJS participants selected a STEM career goal when asked about what they want to be when they grow up. This may have translated into the affinity with STEM based on future goals, and career-related ambitions.

“I need to know science for in the field I want to be in… because it may be someone’s life that I save as a nurse.”

“I am a STEM person. I want to pursue mechanical engineering or a pediatrician”

“I am a science person because I like to explore creepy things! I want to be a mortician and embalmer.”

**Recognition external themes.** The external themes for recognition were related to school, family, and belonging to a community. “I get good grades at school”! “My family encouraged me!” “My friends said it was fun, and I like learning with other girls.”

Participants identified external factors as receiving value, credit, accolades, and reinforcement for interest and achievements in STEM, both inside and outside of the program. Participants described successful experiences in school that supported their ongoing fascination and appeal to STEM, and as ways that they have been recognized for being a STEM person. The following quotes from focus group interviews expressed the participants’ connection to school-related activities and achievement in school as a way to receive recognition.

“I see myself as a math person in STEM. I like it! It is interesting! I skipped pre-algebra and went straight to algebra. I do a lot using math at home around the house.”
“For math I help to tutor people at school. I am good at it, and I try to help people in math and science.”

“(I am) not good in science. My ELA teacher is helping me and encouraged me. She thought that this program would be good to get me more into science and better.”

Another participant expressed the need to receive recognition in a STEM area that may not be her strength. “I am not as strong in math, and I wanted to impress my math teacher by coming here and learning more.”

More than one-third of the participants (38%) indicated that they were encouraged to attend MJS by their parents, and that this encouragement led them to attend MJS. Family influence and reassurance in a STEM identity varied with family members’ support. Families offered reinforcement to participants to do better in STEM subjects at school, to learn more about an area of interest already identified, and to help struggling participants. Family members also served as an example if they were engaged in STEM careers or had an affinity with math or science. Participants commented about family influence.

“I always loved math, and my mom loves it! I am like her.”

“I want to know more about science, and it is a part of my life because I want to be a nurse like my grandma. I need to know math for this also.”

Participants described the learning experience and involvement with the MJS program as a positive event. Numerous statements made about the community of girls and learning with girls added to the benefit of the participants’ involvement in the program. Participants acknowledged the group work and team building activities as a highlight to understanding the group and working in teams, partnerships, and groups. The positive group dynamics were supported by the curriculum, which required partner and team work using
technology that led to shared learning experiences and the collaborative work required for the completion of final presentations. Most activities involved collaboration and promoted learning together. The majority of participants commented on the affirmative activities that encouraged participants to learn about understanding themselves, while learning about STEM skills and knowledge.

A community-builder activity each session focused on the MJS participants getting to know one another and taking a closer look at themselves. Many participants commented on this framework as a way of learning together.

“Playing the games in the morning is super fun. You get to express who you are. Today, Maya (MJS mentor) asked us questions. If the question applied to you, you stood in the middle for a second and walked out. She asked some personal questions.”

“I loved learning about the other girls in MJS.”

“I loved learning about the other girls in MJS. The food was good too. It's also good to know about the issues going on today.”

“The positive parts were getting to know girls that were in the same grade as you and had the same understandings as you.”

Working in groups was another highlight that supported learning about STEM for the participants. Collaboration and team-based activities elevated the experiences of learning and had an affective impact on participants. The activities and opportunities for working together as partners, groups, teams, and with all of the participants helped to develop friendships among the participants. The following quotes provide a sample of the numerous comments made by participants about the connections with recognition, building community, and friendships while recognizing oneself as a STEM person.
“One positive thing is we work with groups.”

“I thought it was positive that I enjoyed using math and science in the real world applications, not just in lectures at school. I also liked working in a team to create graphs and a survey because the information was easier to find, working together.”

“I've made some great friends and it was very fun. I've learned a lot. I've come to love math and like creating graphs.”

“Participating in MJS was one program that I really liked. The positive thing about MJS is meeting new people, learning about Food Deserts and the research we had to do, and the field trips.”

“I learned many new things about math and science, and I began liking the subjects more than I did before. These along with all the new friends I made were the positives of MJS.”

“I made some new friends, went to some new places, learned a ton of new stuff about math and science. We also went on a tour of the campus.”

“Learned a lot, fun, met new people, gained friends, great mentors, experimented a lot. The positive things are endless. :)

“The things I learned and the new friends I have are things I will always remember! This program changed me and I'll never forget my experience. I have new knowledge on food deserts and I am sure this program helped me now and till the end of my days.”

“The positive things are meeting new friends, using inspire data, going on field trips, eating in the cafeteria, revolving which room we are in, playing games in the
morning, getting taken in the building by our group leaders and EVERYTHING THAT HAS HAPPENED THUS FAR.”

“The positive outcomes of participating in MJS are that I am better in math and I enjoy it a lot more. My science skills have strengthened even more than before. I participate a lot more and have more friends.”

“You learn a lot and meet new people. Also, you can participate and learn what it feels like on a campus. You can ask questions and also learn more about computers. You get to eat like a college student.”

“The positive things about MJS is that every girl got along, well at least tried to get along. MJS was the best. One more positive thing is that MJS was very fun!”

**STEM Identity Component 2–Competence.** Defined by Carlone and Johnson (2007), competence refers to knowledge and understanding of STEM (science) that may be less publically visible than performance component of the STEM identity prototype.

Participants demonstrated competence through the articulation of what was learned by documenting this information during the journal reflections where the participants described new knowledge and understanding. No specific criteria or explicit direction was given about how to approach the journal reflections; however, participants were able to document their learning in a non-restrictive framework by responding to three guided open-end questions: What did I learn today? What questions do I have? and I Wish… The journals were not graded or assessed by the mentors; however, the mentors provided a response in the journals in support of the ideas and questions from the participants. The themes that emerged from the competence component of the science identity model included STEM knowledge and skills, vocabulary and use of scientific terms, and digital learning and data analysis.
**STEM knowledge and skills.** “I get this”! MJS participants were prompted to write in their individual journals at the end of each Saturday session. This time was used for quiet reflection, and the mentors often responded to what the participants wrote in their journals the following week. The researcher logged the entries from the MJS journals as a way to verify individual competence, and specifically to understand the knowledge and skills acquired through the activities and engagement during each session. The MJS participants documented scientific knowledge, utilized new STEM vocabulary, and explicitly described activities and new knowledge learned during the MJS weekly sessions during the journal activities.

**Building a STEM vocabulary.** Participants used specific STEM vocabulary and terms in their individual journals that verified new STEM knowledge and skills. Research terms, scientific methods, and technological applications were common in the language in participant journals. Entries demonstrated a wide range of understanding of STEM vocabulary as shown in Table 2.
Table 2

*Journal Entries Revealing Understanding of STEM Terms and Vocabulary—*

“I learned…

<table>
<thead>
<tr>
<th>Topic</th>
<th>Journal Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>what STEM stands for… Science, math, engineering, and Technology.</td>
</tr>
<tr>
<td>Surveys</td>
<td>about open and closed types of questions to put on a survey.</td>
</tr>
<tr>
<td></td>
<td>surveys need to be wide ranged to get accurate data.</td>
</tr>
<tr>
<td></td>
<td>you need a good purpose to have a good survey.</td>
</tr>
<tr>
<td></td>
<td>you should try to have a variety of questions on your survey, not just multiple choice.</td>
</tr>
<tr>
<td></td>
<td>surveys are never made to entertain. It is (for) to collect and analyze data.</td>
</tr>
<tr>
<td></td>
<td>surveys are great to send to my friends and teachers. It would be really cool, case I wanna do a survey about bullying for my school. So now it would be easier. I wish we could do more surveys about a variety of things.</td>
</tr>
<tr>
<td></td>
<td>about surveys and ordinal answers.</td>
</tr>
<tr>
<td></td>
<td>about how to make a surveys and how they involve demographics; which is how to learn about a person.</td>
</tr>
<tr>
<td></td>
<td>surveys gather data from a public perspective.</td>
</tr>
<tr>
<td></td>
<td>surveys are fun…I learned about like grouping and making tables.</td>
</tr>
<tr>
<td></td>
<td>about types of survey categories.</td>
</tr>
<tr>
<td></td>
<td>how to see if surveys are ethical.</td>
</tr>
<tr>
<td></td>
<td>when creating a survey, it is very important to include an “other” choice option.</td>
</tr>
<tr>
<td></td>
<td>the names of many different types of survey questions.</td>
</tr>
<tr>
<td></td>
<td>there are 5 types of closed-ended questions.</td>
</tr>
</tbody>
</table>
surveys can have questions worded differently that mean the same thing.

Table 2 *Continued*

what people think about when they make surveys.

how to determine what types of questions to use.

**Stakeholder**

(Everything) Everyone is a stakeholder to something.

definition of a stakeholder is someone that has something to be lost or gained.

the difference between a sample and total population.

**Topic**

**Journal Entries**

**Demographics**

demographics means information about a person.

the meaning of demographics and where they usually come in a survey.

demographics come at the beginning of a survey.

demographics – for our survey

Gender– F: 85.4%;M: 14.4% (women buy the foods)

Race – white: 63, black: 22, American Indian: 2, Asian: 1, Hispanic: 1

you collect data from different backgrounds and types of people.

there are demographics we need to learn about people we survey.

**Charts and Data Analysis**

different plots to put data in.

how helpful a Venn Diagram can be to organize the same and different

Venn Diagrams can have more than 2/3 circles.

Venn diagrams not only compare and contrast but tell you how much you have in common with someone.
Table 2 Continued

how to represent data in many different ways such as graphs and charts.

about bar graphs.

topics of a Venn diagram cannot be either or topics they must be yes or no.

about the many charts, I did not know that a Venn diagram was a chart.

a Venn diagram is a visual representation of data.

you have to sell the importance of your research.

when to use certain types of graphs.

how to analyze a chart and graph.

doing the KWL chart.

how to take a vote upon the group to gather data.

mean, median and mode.

more about categories.

different ways to sort categories.

how to organize subjects.

a different way to find out percentages.

to collect data and statistics.

about ordinal and categorical it is like your race and rating.

categories should have specified sections.

columns go vertically.

you can take a lot of data from one table.

**Digital learning and data analysis.** The MJS program was organized around a series of digital learning opportunities. Participants accessed portable laptops, computer labs, and the internet as learning tools for exploration, research, data analysis, and the creation of an
original survey. Participants engaged in processes and activities that facilitated learning about valid websites used for research, research of a social issue, and data analysis. Participants created, launched and applied statistical analysis skills towards the development of an original survey that was launched to gather information about how a social issue affected stakeholders’ lives. The final presentation was delivered with the use of a PowerPoint presentation, and included charts and graphs to display the data collection and statistical analysis, which were all skills introduced during the digital learning opportunities.

MJS participants worked in pairs or small groups, and used a collaborative approach to digital learning. For example, the Mission Possible assignment provided groups of two to three an opportunity to use a computer software program to visualize, investigate, and understand data. This work was designed as challenges for each pair or group to complete, and the skills learned from this activity were translated into the final projects when the participants presented the data findings and analysis.

All of the MJS participant journals identified content and skills learned from digital learning experiences at various checkpoints during the program. Most of these entries were short specific statements. This learning was demonstrated during the presentations on the final day of the MJS program. The degree to which individual learning occurred was not directly assessed by the program facilitators. Competence is self-assessed by the individual journal reflections as shown in Table 3 and then demonstrated in a performance setting during the final presentations.
Table 3

*Journal entries about digital learning.*

<table>
<thead>
<tr>
<th><strong>I learned …</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>that I liked working on the computer with the partners.</td>
</tr>
<tr>
<td>how to work with mac computers.</td>
</tr>
<tr>
<td>I loved working with computers and taking surveys.</td>
</tr>
<tr>
<td>how to fix a computer without wi-fi.</td>
</tr>
<tr>
<td>making and editing surveys isn’t easy.</td>
</tr>
<tr>
<td>instructions could have helped me in the editing process.</td>
</tr>
<tr>
<td>I liked that I got to put things in the computer.</td>
</tr>
<tr>
<td>about technology.</td>
</tr>
<tr>
<td>I like the computer lab and scavenger hunt.</td>
</tr>
<tr>
<td>how to find out if a website is real or fake.</td>
</tr>
<tr>
<td>about resources to use during research and citations from the computer for websites.</td>
</tr>
<tr>
<td>more ways to tell if a website is credible.</td>
</tr>
<tr>
<td>the proper way to find out if a site is real or not.</td>
</tr>
<tr>
<td>you can broaden your horizons when it comes to your research.</td>
</tr>
<tr>
<td>how to find good websites to research.</td>
</tr>
<tr>
<td>how to look for the last update of a website.</td>
</tr>
<tr>
<td>researching for papers.</td>
</tr>
<tr>
<td>how to make sure how info is correct when researching a paper.</td>
</tr>
<tr>
<td>how to make sure you’re getting a legitimate website and not getting cheated.</td>
</tr>
<tr>
<td>I liked researching on the computers.</td>
</tr>
<tr>
<td>about how to research and I will use this for doing school work.</td>
</tr>
</tbody>
</table>
Table 3 Continued

how to read and know if a website is good or bad.

how to evaluate a website and how to use the MI library.

if the website is good.

things you can use Inspire Data for.

Inspire Data is when you like to make tables and look at the views.

Inspire Data was challenging, made me want to learn more.

how to narrow things down to get an answer in Inspire Data. I also learned about Ethics

in Inspire Data there is a form and fields to record.

I found 2 different data in inspire data.

about inspire data – you can make a survey on it.

how to read graphs on Inspire Data

to use Inspire data to publish a public a survey.

how to use Inspire Data.

how to make a chart in PowerPoint.

how to fit PowerPoints and make them better.

how to make and edit PowerPoints.

how to format a PowerPoint the right way.

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**STEM Identity Component 3—Performance.** The performance component refers to the demonstration of relevant scientific practices, including ways of talking and using tools Carlone and Johnson (2007). On the 10th and last Saturday, the MJS participants’ parents and the public were invited to attend the MJS presentations of the findings of the social science research project that included statistical data and information from the responses of the
surveys that each team created. Two teams in each room created PowerPoint presentations; the participants in each team individually presented a section of the information and clearly presented their research, findings, and analysis of the data from their surveys in a social setting of 15 to 20 family and friends. Each team defined the social issue, described the demographics of who responded to the survey, provided background information, stated a purpose and hypothesis, and analyzed the responses from the survey. The conclusion was an overview of potential solutions to the social issue based on the survey data and the context of the research connections to the survey results.

The participants used scientific terminology, and the scientific method was applied and noted in the description about the exploration of the research topic and findings. Significant STEM vocabulary was used to present the information. Table 4 captures the performance of the participants during the presentations demonstrating the use of significant scientific approach and using STEM terms and technology.
Excerpts from Final Presentations of MJS Teams

**Team A** Introduction

In MJS we learned about (a social issue) and we used Inspire Data to create graphs. Some of the graphs we created to show our results were the diagrams, bar graphs, and pie charts. And we also went to the University Undergraduate Library where we learned about the different research

**Team B**

Presenter 1 - The survey allowed us to receive data of which the results will be displayed in our presentation.

Presenter 2 - So, this is our data and results. So, this is a pie graph that shows the gender of the people that took our surveys. And so, there were 88 people who took our survey and 72 were female and 16 were males. And this is a bar graph that shows the race and ethnicity, so the majority of the people that took our survey were either Black or African-American, White, or Other. And this is a Venn diagram…

**Team C**

Our hypothesis is that health problems, income, and education can effect where people choose to stop (for food). Some people may have a harder time making healthy food choices than others because of where they live.
Table 4 *Continued*

**Team D**

Health History and Ethnicity – This graph compares family health history and ethnicity. There is a correlation between people who are Caucasian and having a family history of cancer. High blood pressure seems to be common in African-American families.

**Team E**

Our Conclusion – Income and health problems can affect where people shop. People who have a high income may be able to spend more money on healthy food than those who have a lower. Health problems may affect where people shop because they may be required to eat specific food.

**Team F**

At the end of our analysis, one question remained…what can be done? Here’s what we came up with:

We can open stores that carry health foods in food desert areas.

We can teach more people, who do not know about food deserts, what and where they are.

We can give help to people who cannot afford healthy food so they can keep a balanced diet.

And finally, we can educate people about keeping a healthful lifestyle.

**Conclusion**

The data from this study were described and documented in this chapter. Overall, seventh-grade African-American girls who were engaged in the MJS program and interested
in STEM, identified external and internal influences that supported their involvement and interest in STEM activities including a sense of belonging and connectedness to learning with other girls, a desire to learn something new about STEM, and overcoming challenges related to science and math in school. Participants also looked to the future as a motivation for involvement, seeing STEM activities as a pathway to meet career and or college goals.

The MJS program increased levels of interest in STEM for the participants, and increased levels of interest in STEM were transferred from the MJS program to the experiences outside of the program. Most participants described connections that were made from the content and knowledge gained from the MJS program experience as a support and link to classroom learning in STEM subjects. All participants increased their capacity to demonstrate increased knowledge in STEM content as a result of the learning experiences within the MJS program. The learning environment provided multiple opportunities for participants to meet high expectation and access to engaging activities within a supportive, well-managed setting.

The MJS program participants demonstrated behaviors related to building a STEM identity through the components described by Carlone and Johnson (2007), including the following: recognition – internal and external acknowledgement of being a STEM person; competence – demonstrating an understanding of STEM content; and performance – publically exhibiting STEM knowledge and skills. The next chapter will provide a closer look at the implications of these findings, with an emphasis on the components of building a STEM identity during the MJS program.
Chapter V–Conclusions and Recommendations

This chapter includes the findings, conclusions, implications, and recommendations for further research related to this study. This qualitative study explored the identity development of participants related to STEM experiences in the Mae Jemison STEM (MJS) program. Data were collected on-site through focus group interviews, learning environment observations, journals, video recordings of final presentations, and MJS artifacts and documents related to the experiences of the seventh-grade African-American girls attending the MJS program as the 2014 cohort. The study included an analysis regarding STEM interests of the girls who participated in the MJS program. Experiences in the program that influenced the development of a STEM identity were also analyzed to explore the impact of the MJS learning environment.

The purpose of this study was to determine what inspires or leads seventh-grade African-American girls toward an interest in STEM, to characterize and describe the context of an out-of-school STEM learning environment, explore the impact on the seventh-grade African-American girls who participated in the program as it relates to individual STEM identity, and to identify personal and academic experiences of seventh-grade African-American girls that contribute to the discouragement or pursuit of science and math-related academic pathways and careers.

Addressing the Research Questions

Research Question 1. What influences African-American seventh-grade girls to select and engage in an afterschool experience related to STEM?
The majority of the participants identified external factors such as family and school and social context as the main influences that led them to participate in the MJS program.

“My mom’s friend told her about it, and then my mom showed me what it was about online.”

“For math, my family wants me to do more, but I am not good at it. I like science because of the experiments.”

“I am not good in science, but my ELA teacher is helping me and encouraged me because she said it would help my work.”

“I wanted to meet new friends and get ahead with some opportunities.”

“My sister's friend was in the program and said it was fun”!

Some of the participants identified internal factors such as an interest in STEM, a desire to improve academic skills, and college acceptance as rational for involvement in the MJS program.

“I like science and technology.”

“I really like math and science, and I want to be a better presenter and have more social skills.”

“I was transferred to a new school, and it is not a challenge. I wanted to be in something that would help me with my academics.”

“I thought it would be a good experience, and help with college acceptance.”

**Research Question 2.** What are the factors that may support, encourage, or motivate the African-American girls who participate in the MJS program to engage or pursue higher level science and math experiences, and courses that may lead to careers in STEM?
Exposure and current involvement in higher-level STEM in and out of school experiences, course work, afterschool programs, and an internal desire to learn more or achieve a STEM-related career were factors that supported and motivated participants to aspire to engage in higher-level high school and college-level courses, including a variety of specialized and advanced math and science classes, afterschool STEM-related programs, and independent activities and exploration of computers, gaming and technology.

“I would like to take (advanced) science, so I can dissect things. And I would also like to do math because I want my college math level to be high.”

“I would like to take (advanced) science, so I can dissect things. And I would also like to do math because I want my college math level to be high.”

“It will help me to learn more about the body.”

“I really like science classes and I want to advance in this subject. I would also like to advance in math because it could help me later in life and help me choose a job that I will like.”

“I liked GSA (afterschool STEM program), and the math and science that we did was hard but good.”

**Research Question 3. What are the levels of interest in science and math for African-American girls before and after their participation in the MJS program?**

Many participants entered the program with an interest in STEM and just more than half of participants already had a career-related interest in STEM as a future aspiration. The majority of participants identified an increased level of interest in STEM at the end of the program and made connections to improvement in understanding course work at school, real life application, and new knowledge and skills.
“When I first started I did not like math; now I like it and I feel more comfortable and I understand it better. This has made it better in school. For science I was already comfortable.”

“Before GG I really did not like science; after, I know science can be fun in learning the foundation and education.”

“M – I liked math before and now I like it even more! Because the survey shows how science and math are different and alike; and there are different ways to look at math problems.”

**Research Question 4.** *How does the learning environment support, encourage, or inspire the girls in STEM?*

The learning environment provided significant levels of well-managed, active participant engagement with high expectations and supportive conditions. The experiences with digital learning were important for participants as this component of the environment was integrated throughout the learning; even when the participants were not directly engaged in the use of technology, there was a direct transference of what was learned while using technological devices to other learning conditions which promoted collaboration, and the creation of original works.

Although the digital learning environment criteria was not rated in the top three conditions for an optimal learning, it is noteworthy due to the responses and feedback from participants who reported in journal reflections that this was an area that had an extraordinary impact on STEM content that was learned and identified.

**Research Question 5.** *How do African-American girls who participate in the MJS program identify with STEM as a part of building and creating their own personal identity?*
According to the theoretical framework adapted from Carlone and Johnson’s (2007) grounded theory of science identity for women of color, participants in the MJS program identified with STEM and increased their connections as it related to the three components of the framework: recognition, competence, and performance.

Recognition–Participants identified internal and external recognition factors related to building a STEM identity. This included recognizing oneself as a STEM person, and being recognized by others (external) as a STEM person.

The internal factors of recognizing oneself as a STEM person were identified by participants as affective feelings about areas of STEM, such as “I love computers”! or “I am good at math!” Personality traits were also described as internal recognition, such as “I like to figure things out”, and “I am a curious person.” Feelings of enjoyment and success and connections to STEM skills combined connected participants to recognizing themselves as STEM persons, such as algebraic problem-solving, hands-on experiments, chemistry, biology, figuring out how things work, scientific formulas, and so on. Participants identified whether they were STEM persons and described whether they enjoyed related subjects at school and the success they had. Characteristics such as intelligence, discoverer, curious, open-minded, organized, explorer, and patience were connected to reasons that participants identified themselves as being STEM persons.

The external factors that contributed to the participants’ identification with STEM included their interpretation of successful experiences in school; family influence, encouragement, and connections; knowing someone in STEM; and a sense of belonging and learning STEM with other girls. Successful experiences in school were mainly identified through the attainment of excellent grades in subjects; for example, “I get all A’s in science!”
Family influence included reinforcement and inspiration to join in out-of-school experiences, and praise for STEM abilities. Participants also noted family members in STEM fields that they admired or wanted to be like. “My mom is great at math and I am too!” “My grandmother is a nurse, and that is what I want to be.” Participants also noted the experience with learning with other girls and strongly related to the community-building activities to support positive collaborative relationships. “I loved learning about the other girls.” “We had to work together to make the surveys.” “I made new friends and I learned a lot.” “I’ve come to love math and creating graphs.”

Competence—The participants increased competence as a factor that contributed towards a STEM identity. Increased competencies were noted through knowledge and skills in STEM, demonstration of building a STEM vocabulary, and use of technology and digital learning. Participants individually described the meaning of STEM and how this is connected to who they are; used scientific terms related to STEM, surveys components including stakeholders and demographics; identified and used appropriate charts for data analysis such as plot graphs, Venn diagrams, bar charts, and so on; used digital devices to research information, create charts and graphic data images, and conducted data analysis.

Performance—The performance component of building a STEM identity refers to the demonstration of relevant scientific practices, including ways of talking and using tools (Carlone and Johnson, 2007). Teams of participants presented the research findings and analysis of the data collected from a survey that they created and launched online. Participants used scientific terminology and a PowerPoint software program to guide the presentation. The presentations were 15 to 20 minutes in length and required the participants to speak in front of an audience of 12 to 18 people who were parents, family, and friends of
the MJS participants. Each team provided a description of their topic, hypothesis, and procedures of the surveys, displayed the graphs, and charts that represented the findings, and discussed their conclusions and responses to the question, “what can be done about this issue?”

**Discussion of Findings**

Analysis of the data collection led to multiple findings related to each research question, and the underpinning theoretical framework of building a STEM identity based on Carlone and Johnson’s (2007) grounded theory of science identity for women of color. The overall findings of the data collected in this study include the following:

- Seventh-grade African-American girls who were engaged in the MJS program and interested in STEM were able to identify both external and internal influences that supported their involvement and interest in STEM activities.

  Participants identified external advocates such as family, school, or other STEM-related programs as influences that led to engagement with the MJS program. Internal factors, such as an interest in STEM and future aspirations related to STEM were also identified as rational for participation in the program.

  Chatman’s (2011) findings are also parallel to the significance of the impact of external and internal influence. Chatman’s qualitative case study explored factors that affect the mathematical achievement of middle school African-American females. The results included both external and internal influences as essential for improvement and building confidence in mathematic achievement.

- Learning about STEM during the MJS program provided an opportunity for participants to overcome challenges related to science and math knowledge and
skills in school. Participants also looked to the challenges of the future and the MJS program as support for improving STEM involvement and a connection to a pathway to meet career and or college goals.

Some participants described a desire to “do better” and improve STEM knowledge or skills as a way to be successful in the future. The ability to overcome obstacles against the odds has been illustrated in recent research as resilience or grit. Duckworth (2013), and Shechtman, DeBarger, Dornsife, Rosier, & Yarnall, (2013) defined the concept of grit as the quality of persistence over time to overcome challenges and accomplish big goals. MJS participants referenced meeting challenges as a rational for being in the program. This also supports Feldman & Matjasko’s (2005) research on engagement in afterschool programs as a way to teach self-discipline and persistence through structured opportunities to challenge themselves, learn through failure, and experience improvement.

- The MJS program increased levels of interest in STEM for the participants, and the increased levels of interest in STEM were transferred from the MJS program to the experiences outside of the program.

Participants noted a direct relationship between what and how they were learning in the MJS program to increased competencies at school. An overwhelming amount of research supported this finding including Feldman & Matjasko’s (2005) research that linked afterschool programs to reduced dropout and substance abuse rates and higher levels of college enrollment.
• All participants increased their capacity to demonstrate increased knowledge in STEM content as a result of the learning experiences within the MJS program.

  Mixed results in effectiveness of afterschool programs range from having a significant impact to having no impact at all (Jenner & Jenner 2007). McLaughlin (2000) described the range in effectiveness in terms of whether the program was actually selected by the participant rather than a required placement. However, high-quality STEM afterschool programs produce positive outcomes including the improved attitudes toward STEM fields and careers, increased STEM capacities and skills, and increased likelihood of graduation and pursuing a STEM career (Velez, 2011; Aronson, 2008; Mielke et al. (2010); Nelson, 2011 Afterschool Alliance, 2011).

• The learning environment provided multiple opportunities for participants to meet high expectations and provided access to engaging activities within a supportive, well-managed setting.

  Research studies revealed that afterschool programs provide a child- or youth-centered approach versus a curriculum that drives the program (McLaughlin, 2000). The finding related to high levels of supportive learning environment conditions are aligned with this research. Afterschool programs complement and supplement learning and are designed to engage and motivate at-risk students. Successful afterschool programs are not the same as the usual school day. Academic skills are important; however personal relationships, program selection based on interest and individual talents, and a focus on building self-confidence and self-efficacy in academics have been identified as conditions
that support effective afterschool programs meeting specified goals and missions (Huang & Cho, 2009).

- The MJS program participants demonstrated behaviors related to building a STEM identity through the components described by Carlone and Johnson (2007), including recognition–internal and external acknowledgement of being a STEM person; competence–demonstrating an understanding of STEM content; and performance–publicly exhibiting STEM knowledge and skills. Building a STEM identity is described in detail in the next section in regard to the major findings.

**Major Findings**

The major findings are related to the underpinning of this study, as it pertains to what it means for seventh-grade African-American girls interested in STEM to develop a STEM identity. The theoretical framework from Carlone and Johnson’s (2007) grounded theory regarding science identity for college women of color was used to understand how the participants in MJS developed a STEM identity. In Carlone and Johnson’s longitudinal study, the factors that supported the recognition component of building a science identity were a strong predictor for science identity and follow-through for college women of color and pursuit of STEM-related degrees and careers. The other two components, competence and performance, were necessary factors to increase levels of a science identity.

The MJS program participants demonstrated behaviors, knowledge, and skills related to building a STEM identity. The following section describes the findings through the lens of the theoretical framework and components described by Carlone and Johnson (2007), including the following: recognition–internal and external acknowledgement of being a
STEM person; competence—demonstrating an understanding of STEM content; and performance—publically exhibiting STEM knowledge and skills.

**Recognition – internal and external acknowledgment of being a STEM person.**

Seventh-grade African-American girls who were engaged in the MJS program and interested in STEM identified both external and internal influences that supported their involvement and regard for STEM activities. External influences such as school and family provided support and exposure for the participants’ involvement and connection to STEM activities. Internal interest and influence were elevated due to the external factors and relationships at home and school. For example, one participant had a teacher who selected the participant to attend an out-of-school experience and increased the level of exposure to STEM activities.

“My science teacher selected me to go on a field trip. We had to build a path for a bus to get through. I liked it that we used math and science together, and had to figure out the right tools to do the activity.” Another participant indicated that her grandmother saved people’s lives as a nurse, and the participant related to that as something that she also wanted to do.

This finding has implications for retaining girls who have an interest in STEM, and is supported by other research studies. Seventh-grade African-American girls who express an interest in STEM respond to the external positive influences from school, afterschool programs, and family. Spearman & Watt (2013) illustrated a positive relationship with the experiences and perceptions in school, and middle school girls’ motivation for involvement in STEM. Chatman (2011) explored the perception of the girls’ math experiences and the internal and external characteristics that influenced achievement. The findings of this study identified external influences such as the teacher and peers who helped to shape attitudes towards mathematics. Several researchers have also studied the impact of family and
particularly parent expectations as a positive influence on academic interest for African-American students (Eccles, Wong, and Peck, 2006); however, this is not specific to African-American middle schools girls, and there is little research that is focused on schools or family influence and motivation and interest for African-American girls.

Participants in this study also identified external and internal influences that supported future aspirations as reason for involvement in the program in order to meet STEM career pathways or college goals. Once again, family, school, and individual interest were identified as the main external and internal influences for motivation towards STEM pathways and or career goals.

**Competence – individual understanding of STEM.** The MJS program increased participant levels of interest in STEM, and this interest extended to a desire and motivation to elevate levels of understanding and additional learning about STEM content, knowledge, and skills. Participants’ new knowledge and understanding about STEM were transferred from the MJS program to experiences outside of the program, including school and real life application. “Surveys are great to send to my friends and teachers. It would be really cool cause I wanna do a survey about bullying for my school. So now it would be easier. I wish we could do more surveys about a variety of things.” “I learned how to research, and I will use this for doing school work.”

The MJS program attracted seventh-grade African-American girls with an interest in STEM, and inspired motivation to learn more about STEM based on this interest. However, some of these participants were interested in STEM activities to improve STEM-related skills and academics. Some participants entered the MJS program with a desire to improve STEM
skills: “I struggle in math and science, and maybe this could help. It (the MJS program) looked interesting online.”

Learning about STEM during the MJS program provided opportunities for participants to overcome challenges related to science and math knowledge and skills in school. The implication for this finding identified resiliency such as persistence as a way for African-American girls to improve STEM skills. The concept of resilience is a parallel finding to Chatman’s (2011) study on influential factors that support mathematical achievement of middle school African-American females. Feldman & Matjasko (2005) identified and discussed thoughtfully delivered out-of-school activities as a venue to help adolescents develop persistence through structured opportunities in order to challenge themselves and experience improvement.

The MJS program provided support for motivated participants with an interest in STEM to expand new knowledge and experiences related to learning about STEM and also provided an opportunity for participants interested in challenging themselves to improve STEM knowledge and skills.

**Performance** – **public verbal demonstration of relevant STEM practices, with the use of scientific tools.** All participants increased their capacity to demonstrate increased knowledge in STEM content as a result of the research project and learning experiences within the MJS program. Participants used tools such as surveys, graphs, charts, and diagrams; data collection; statistical analysis; and PowerPoint programs to present the research, data collection, and findings of the STEM project investigation during the MJS program. The implication for this finding supports the overlap of the science identity model in Figure 1 (Carlone and Johnson, 2007). Participants gained a perspective regarding STEM
through learning experiences and individual and collective development of additional STEM knowledge, skills, and disposition (competence). This learning process evolved towards the individual and collective demonstration of this knowledge (performance). The presentation and demonstration of this knowledge then led to the recognition factors as participants are applauded and acknowledged for the work and completion certificates received for successful engagement and participation in the MJS program.

The findings in this study suggest that the MJS program provided a learning environment that supported and increased African-American seventh-grade girls’ interest, knowledge, and skills in STEM and added to the development of a STEM identity. Providing extended opportunities for exposure to STEM learning environments with high expectations, to facilitate and build increased levels of competencies, and performance of STEM skills (and knowledge) leads to adding to the recognition of a STEM identity which is a predictor of retaining women of color in STEM careers and college completion. Perhaps building this recognition in the seventh grade for African-American girls will lead to the completion of a college degree and career in STEM (Carlone & Johnson 2007, Carlone, Johnson, Brown, & Cuevas, 2011). The MJS program has the potential to retain African-American girls in STEM and decrease the gap of underrepresentation in STEM fields.

**Recommendations for Future Research**

This research study focused on seventh-grade African-American girls interested in STEM and the impact of the MJS program on building a STEM identity. However, the study did not connect racial and gender identity to building a STEM identity and how this may intersect with advancement towards college and career choices.
Findings of this research study indicated that participant experiences in the MJS program added to building a STEM identity through recognition, competence, and performance. There was also an increase in STEM knowledge and skills for participants with an interest in STEM within an effective learning environment. However, the exact measurement in growth is unknown as to as it relates to STEM identity, knowledge, and attainment. Furthermore, most of the participants came to the program with an interest in STEM and desire to learn more about STEM and expand experiences with STEM. Other participants came to the program with a desire to improve STEM knowledge and skills based on challenges faced while engaged with math and science at school. Further research in the area of understanding resilience and beating the odds in overcoming challenges related to gender and race issues in STEM may support African-American middle school girls in the pursuit of STEM academic and career pathways.

The framework of the MJS program relies heavily on the mentor program and facilitation of STEM activities within a single-gender environment. The mentors were aspiring teachers selected to participate in a unique pre-teaching course and experience. The nature of this particular study did not address the mentors, or the mentor course and program. Future studies may explore the impact that the MJS program has on preparation for teacher certification and classroom leadership experiences.

The following additional questions offer direction for future studies:

1. To what extent does the MJS program support participants with the pursuit and attainment of STEM college and career goals?
   a) What high school STEM-related courses do participants select?
b) What are the college majors of participants? How many participants choose a STEM-related field of study?

c) How many graduates of the MJS program have STEM careers?

d) What are the future supports and disruptions for pursuit of STEM college and career choices?

2. How do African-American middle schools girls interested in STEM construct identity as it relates to STEM, racial, and gender identity development?

   a) How does racial, gender and STEM identity intersect?

   b) How does experiences in school and home support racial, gender and STEM identity, and the pursuit of a STEM college degree and career?

3. What are the most conducive/effective conditions/setting for optimizing STEM learning for girls African-American girls?

   a) How does collaboration and community within a single gender environment support African-American girls learning STEM?

   b) What is the impact of a competitive STEM learning environment?

   c) How does the inclusion of social issues impact integrated STEM learning for African-American girls?

4. Why do mentors select the MJS program as the pre-teaching experience?

   a) What is the impact of the MJS setting on teaching pedagogy for mentors’ development as pre-teachers?

   b) How does the MJS program influence mentors understanding of at-risk and talented African-American girls, and how does this translate into future teaching practices.
Summary

Finding ways to retain African-American girls in STEM is complex and includes multiple variables. The results of this research study adds to the body of knowledge regarding the significance of internal recognition, which begins with an individual interest in STEM, and external influences such as family, school, and community that encourage and inspire active participation in STEM. The MJS program has added to the recognition of STEM for participants and increased levels of knowledge, skills, and interest for African-American seventh-grade girls who were interested in STEM, and supported participants struggling with related subjects in school. Perhaps the impact of this program will support overcoming obstacles and resilience of participants in support of the pursuit of STEM-related fields for those that struggle in school and add to decreasing the gap in the representation of African-American women engaged in STEM.
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Appendixes
Appendix A University Human Subjects Research Committee Approval

EASTERN MICHIGAN UNIVERSITY

December 4, 2013

UHSRC Initial Application Determination: EXPEDITED APPROVAL

To: Beverley Fiona Hinds
   Eastern Michigan University - Leadership and Counseling/College of Education

Re: UHSRC # 131114

Category: Approved Expedited Research Project

Approval Date: December 4, 2013

Title: A qualitative study of the experience of female African-American seventh graders who participate in a science, technology, engineering, math (STEM) afterschool program, and the impact this experience has on developing a STEM identity

The Eastern Michigan University Human Subjects Review Committee (UHSRC) has completed their review of your project. I am pleased to advise you that your expedited research has been approved in accordance with federal regulations.

Renewals: Expedited protocols need to be renewed annually. If the project is continuing, please submit the Human Subjects Continuation Form prior to the approval expiration. If the project is completed, please submit the Human Subjects Study Completion Form (both forms are found on the UHSRC website).

Revisions: Expedited protocols do require revisions. If changes are made to a protocol, please submit a Human Subjects Minor Modification Form or new Human Subjects Approval Request Form (if major changes) for review (see UHSRC website for forms).

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to human subjects and change the category of review, notify the UHSRC office within 24 hours. Any complaints from participants regarding the risk and benefits of the project must be reported to the UHSRC.

Follow-up: If your expedited research project is not completed and closed after three years, the UHSRC office will require a new Human Subjects Approval Request Form prior to approving a continuation beyond three years.

Please use the UHSRC number listed above on any forms submitted that relate to this project, or on any correspondence with the UHSRC office.

Good luck in your research. If we can be of further assistance, please contact us at 734-487-0042 or via e-mail at gs_human_subjects@emich.edu. Thank you for your cooperation.

Sincerely,

[Signature]

Dr. Jennifer Kellman Fritz
Faculty Co-Chair

University Human Subjects Review Committee - Eastern Michigan University - 200 Boone Hall Ypsilanti, Michigan 48197 Phone: 734.487.0042 Fax: 734.487.0050 E-mail: human.subjects@emich.edu www.ord.emich.edu (see Federal Compliance) The EMU UHSRC complies with the Title 45 Code of Federal Regulations part 46 (45 CFR 46) under FWA0000050.
Appendix B   Informed Consent Form – Parents and Guardians

Project Title: Developing a Science Technology Engineering and Math (STEM) Identity

Investigator: B. Fiona Hinds, Eastern Michigan University

Purpose of the Study: This is a research study that will investigate the experience of female African-American seventh graders who participate in a STEM afterschool program. This study will also explore and examine the learning environment of the afterschool experience; and identify levels in the development of a STEM identity for African American girls who participate in the program.

Procedure: I will explain the study to you, answer any questions you may have, and witness your signature to this consent form. Your consent will allow your child to take part in this study during the [redacted] program. The participants will be observed during Saturday sessions scheduled January 25, 2014 – April 12, 2014. Observations will include the program activities, participation in group/individual interviews, and journal reflections. Observations, activities and interviews may be recorded by note-taking, and/or audio recording.

Confidentiality: The name of the program and students will not be used and their confidentiality will be protected. At no time will your name or child be associated with the study. All related materials and recordings will be kept in locked file cabinets in the researcher’s office and electronic data will be stored on a password-protected computer.

Expected Risks: There are no foreseeable risks to you or your child by participating in this study, as all results will be kept completely confidential.
**Expected Benefits:** There will be no direct personal benefit to you or your child, but your participation will contribute to our understanding of how this program supports the development of a science and math identity.

**Voluntary Participation:** Participation in this study is voluntary. You and/or your child may choose not to participate without negative consequences. If you do decide to participate, you can change your mind at any time and withdraw from the study without negative consequences.

**Use of Research Results:** Results will be presented as a cohort group format only. No names or individually identifying information will be revealed. Results may be presented at research meetings and conferences, in scientific publications, and as part of a doctoral dissertation being conducted by the principal investigator.

Future Questions: If you have any questions concerning your participation in this study now or in the future, you can contact the principal investigator, B. Fiona Hinds, at 313-215-2039 or via e-mail bhinds@emich.edu

**A duplicate copy of this informed consent will be provided to you, which includes follow-up contact information, if needed.**

This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from January 25, 2014 to April 12, 2014. If you have questions about the approval process, please contact the Director of the Graduate School (734.487.0042, human.subjects@emich.edu).
Consent to Participate:

I have read or had read to me all of the above information about this research study, including the research procedures, possible risks, side effects, and the likelihood of any benefit to me. The content and meaning of this information has been explained and I understand. All my questions, at this time, have been answered. I hereby consent and do voluntarily offer to follow the study requirements and allow my child to take part in the study.

Parent/Guardian PRINT NAME: _________________________________________

PRINT CHILD’S NAME: _________________________________________________

Signatures:

Parent/Guardian (your signature) Date

__________________________________________  ____________

Investigator or Specified Designee Date

__________________________________________  ____________
Informed Consent Form – Participants

**Project Title:** Developing a Science Technology Engineering and Math (STEM) Identity

**Investigator:** B. Fiona Hinds, Eastern Michigan University

**Purpose of the Study:** The study will investigate your experiences in the [GO GIRL] program and the impact that these experiences have on your development of a STEM identity.

**Procedure:** I will explain the study to you, answer any questions you may have, and witness your signature to this consent (agreement) form. Your consent and your parent/guardian’s consent will allow you to take part in this study during the program. You will be observed during activities, participate in group/individual interviews, and share your STEM journal reflections. Observations, activities and interviews may be recorded by note-taking, and/or audio recording. You will receive a copy of this informed consent form, which includes follow-up contact information, if needed. You may contact me with any questions about the study.

**Confidentiality:** Your name will not be used and this will be kept as confidential. At no time will your name be identified. All of the materials and recordings will be kept in locked file cabinets in the researcher’s office and electronic data will be stored on a password-protected computer.

**Expected Risks:** There are no risks to you by participating in this study, as all results will be kept completely confidential.
Expected Benefits: There will be no direct personal benefit to you, but your participation will contribute to a greater understanding of how this program supports the development of a science and math identity.

Voluntary Participation: Participation in this study is voluntary. You may choose not to participate without negative consequences. If you do decide to participate, you can change your mind at any time and withdraw from the study without negative consequences.

Use of Research Results: The results will be presented to show the collected information that represents the Winter 2014 cohort as a group. No names or individual information will be revealed. Results may be presented at research meetings and conferences, in scientific publications, and as part of a doctoral dissertation being conducted by the principal investigator.

Future Questions: If you have any questions concerning your participation in this study now or in the future, you can contact the principal investigator, B. Fiona Hinds, at 313-215-2039 or via e-mail bhinds@emich.edu

This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from January 25, 2014 to April 12, 2014. If you have questions about the approval process, please contact the Director of the Graduate School (734.487.0042, human.subjects@emich.edu).
Consent to Participate:

I have read or had read to me all of the above information about this research study, including the research procedures, possible risks, side effects, and the likelihood of any benefit to me. The content and meaning of this information has been explained and I understand. All my questions, at this time, have been answered. I hereby consent and do voluntarily offer to follow the study requirements and take part in the study.

PRINT NAME:  __________________________________________

Signatures:

Participant (your signature)  Date

_________________________________________  ______________

Investigator or Specified Designee  Date

_________________________________________  ______________
Informed Consent Form – Mentors

Project Title: Developing a Science Technology Engineering and Math (STEM) Identity

Investigator: B. Fiona Hinds, Eastern Michigan University

Purpose of the Study: This is a research study that will investigate the experience of female African-American seventh graders who participate in a STEM afterschool program. This study will also explore and examine the learning environment of the afterschool experience; and identify levels in the development of a STEM identity for African American girls who participate in the program.

Procedure: I will explain the study to you, answer any questions you may have, and witness your signature to this consent form. Your consent will allow you to take part in this study during the GO GIRL program. The researcher will observe the professional development training for the mentors on January 11 and 18, 2014; and the GO GIRL participants will be observed during Saturday sessions scheduled January 25, 2014 – April 12, 2014. Observations will include the program activities, participation in group/individual interviews, and journal reflections. Observations, activities and interviews may be recorded by note-taking, and/or audio recording. Although the study is not focused on the mentors, the researcher will record observations during the professional development of the mentors and during times when the mentors are present and engaged with facilitating the participants in the exploration of STEM through program activities. The researcher shall receive consent from the mentors for these observations due to the presence of the mentors and their involvement with the participants during the learning environment observations.
Confidentiality: The name of the program and mentors will not be used and their confidentiality will be protected. At no time will you be associated with the study. All related materials and recordings will be kept in locked file cabinets in the researcher’s office and electronic data will be stored on a password-protected computer.

Expected Risks: There are no foreseeable risks to you by participating in this study. All results will be kept completely confidential.

Expected Benefits: There will be no direct personal benefit to you, however your participation will contribute to a greater understanding of how this program supports the development of a science and math identity.

Voluntary Participation: Participation in this study is voluntary, refusal to participate will not jeopardize your role as a mentor. You may choose not to participate without any negative consequences. If you do decide to participate, you can change your mind at any time and withdraw from the study without negative consequences.

Use of Research Results: Results will be presented as a cohort group format only. No names or individually identifying information will be revealed. Results may be presented at research meetings and conferences, in scientific publications, and as part of a doctoral dissertation being conducted by the principal investigator.

Future Questions: If you have any questions concerning your participation in this study now or in the future, you can contact the principal investigator, B. Fiona Hinds, at 313-215-2039 or via e-mail bhinds@emich.edu
A duplicate copy of this informed consent will be provided to you, which includes follow-up contact information, if needed.

This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from January 11, 2014 to April 12, 2014. If you have questions about the approval process, please contact the Director of the Graduate School (734.487.0042, human.subjects@emich.edu).

Consent to Participate:

I have read or had read to me all of the above information about this research study, including the research procedures, possible risks, side effects, and the likelihood of any benefit to me. The content and meaning of this information has been explained and I understand. All my questions, at this time, have been answered. I hereby consent and do voluntarily offer to follow the study requirements and allow my child to take part in the study.

Mentor PRINT NAME: _________________________________________

Signatures:

Mentor (your signature)            Date

____________________________________________________________________  _________________

Investigator or Specified Designee            Date

____________________________________________________________________  _________________
Appendix C  Text/Script to Describe the Research Study

The following scripts was used to present information about the research study and support an explanation of the informed consent forms. This information was verbally presented and shared in person and on-site during the activities and on the following dates:

- Mentor Orientation - Saturday, January 11th, 2014
- Saturday, January 18th, 2014 for the parents/guardians and participants.
- Saturday, February 8, 2014 for the parents

Hello Parents and [GO GIRLS]!

My name is B. Fiona Hinds, and I am a doctoral candidate at Eastern Michigan University in Ypsilanti Michigan. For my dissertation topic I have selected the [GO GIRLS] program to study the impact that the program has on the development of a science, technology, engineering, and math (STEM) identity for African-American seventh grade girls.

Participation in the study will require written permission from the parents/guardians of the girls who are in the [GO GIRLS] program, and the girls/participants themselves.

You are not required to participate in the study. It is voluntary, and if you decide not to participate this will not have any negative consequences for you or your child. You can participate in the [GO GIRLS] program and decide not to participate in this study.

If you decide to participate in the study, and provide consent to participation, you or your child may change your mind and withdraw participation at any time during the study without negative consequence.

Individual participants will be anonymous and I, the researcher will protect the anonymity of the participants involvement and contributions towards the study by not using any names
including the name of the program. The name of the program and girls will not be used and their confidentiality will be protected. At no time will your name or child be associated with the study. All related materials and recordings will be kept in locked file cabinets in my office and electronic data will be stored on a password-protected computer.

Please review the Informed Consent Letter and make sure that you understand the information. I will be here for any additional questions, or you may contact me via email or phone as indicated on the form. You may turn this form in today, or you may turn it in on the first day of the session next week on January 25. I will provide you with an additional copy with my contact information so that you can contact me individually with any additional questions.

Remember, if you decide to participate in the study, and provide consent to participation, you or your child may change your mind and withdraw participation at any time during the study without negative consequence. Do you have any questions about the research study or the Informed Consent Form?

Thank you.
Hello Mentors!

My name is B. Fiona Hinds, and I am a doctoral candidate at Eastern Michigan University in Ypsilanti Michigan. For my dissertation topic I have selected the GO GIRL program to study the impact that the program has on the development of a science, technology, engineering, and math (STEM) identity for African-American seventh grade girls.

Participation in the study will require written permission from the parents/guardians of the girls who are in the GO GIRL program, and the girls/participants themselves; and also from you as the mentors who facilitate the STEM learning environments. Although the study is not focused on the mentors who are working with the participants, I (the researcher), will record observations during the professional development of the mentors and during times when the mentors are present and engaged with and facilitating the girls in the exploration of STEM through-out the program activities. The researcher shall receive consent from the mentors for these observations due to the presence of the mentors and their involvement with the participants during the classroom observations.

You are not required to participate in the study. It is voluntary. If you decide not to participate in the study, there will not be any negative consequences. If you decide to participate in the study, you may change your mind and withdraw your participation at any time. The opportunity and option to deny participation or withdraw from the study at any time after consent, will not have any negative consequences to your role as a mentor.

Individual participants will be anonymous and the researcher will protect the anonymity of your involvement and contributions towards the study by not using any names, including the name of the program. At no time will your name be associated with the study. All related
materials and recordings will be kept in locked file cabinets in my office and electronic data will be stored on a password-protected computer.

Please review the Informed Consent Letter and make sure that you understand the information. I will be here for any additional questions, or you may contact me via email or phone as indicated on the form. You may turn this form in today, or you may turn it in next week at the next professional development session. I will provide you with an additional copy with my contact information so that you can contact me individually with any additional questions.

Remember, if you decide to participate in the study, and provide consent to participation, you may change your mind and withdraw participation at any time during the study without negative consequence.

Do you have any questions at this time about the research study or the Informed Consent form? Thank you.
Appendix D  Focus Group Questions

- Describe what attracted you to the MJS program?
- What do you want to be when you grow up?
  - Session 1 – Individual Teams Interviewed: A, B, C
  - Session 2 - Individual Teams Interviewed: D, E, F

- Describe the previous STEM experiences that you have had in and out of school.
- What are the math and science classes that you have been engaged in at school?
  - Session 3 – Individual Teams Interviewed: B, C, E
  - Session 4 – Individual Teams Interviewed: D, A, F

- Describe what type of person is a science, math or STEM person?
- Describe what it means for you to be a STEM person, scientist, mathematician…?
  - Session 5 – Individual Teams Interviewed: F, C, D
  - Session 6 – Individual Teams Interviewed: E, A, B

- What type of math and science classes would you like to take in high school? Why would you like to take these classes?
- What type of math and science classes would you like to take in college? Why would you like to take these classes?
  - Session 7 – Individual Teams Interviewed: A, B, C, D, E, F,

- What did you think about math and science before the MJS program? What do you think about math and science after the MJS program?
  - Session 8 – Individual Teams Interviewed: A, B, C, D, E, F,

- Describe the most exciting or important thing that you learned in the program?
- What were the positive and negative things about participating in the program?
  - Session 9 – Individual Journal Prompt … All participants