The Impact of Length of Engagement in After-School STEM Programs on Middle School Girls

by

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ABSTRACT

An underrepresentation of females exists in the STEM fields. In order to tackle this issue, work begins early in the education of young women to ensure they are interested and have the confidence to gain a career in the STEM fields. It is important to engage girls in STEM opportunities in and out of school to ignite their interest and build their confidence. Brigid Barron's learning ecology perspective shows that girls pursuing STEM outside of the classroom is critical to their achievement in the STEM pipeline. This study investigated the impact after-school STEM learning opportunities have on middle school girls by investigating (a) how the length of engagement in after-school programs can affect the confidence of female students in their science and math abilities; (b) how length of engagement in after-school programs can affect the interest of female students in attaining a career in STEM; (c) how length of engagement in after-school programs can affect interest in science and math classes; and (d) how length of engagement can affect how female students' view gender parity in the STEM workforce. The major findings revealed no statistical significance when comparing confidence in math or science abilities or the perception that gender plays a role in attaining a career in STEM. The findings revealed statistical significance in the areas when comparing length of engagement in the girls' interest in their math class and attaining a career in three of the four STEM fields: science, technology, and engineering. The findings showed that multiple terms of engagement in the after-school STEM programs appear to be an effective catalyst to maintain the interest of girls pursuing STEM-related careers, in addition to allowing their interest in a topic to provide a new lens for the way they see their math work during the school day. The implications of this study show that schools

must engage middle school girls who are interested in STEM in a multitude of settings, including outside of the classroom in order to maintain engagement in the STEM pipeline.

DEDICATION

This dissertation is dedicated to the group of women
who influenced my life in ways they cannot understand.
My girls who are committed to being the next generation of scientists
and engineers, in particular Alexis, Amy, Mason, and Vanessa.
Your dedication to careers in STEM are what inspired this entire project.
The love you gained for science in middle school still inspire me to this day.

I dedicate this dissertation work to my wife, Stephanie.
Your endless encouragement and your ceaseless pushing helped me
with this study, especially when I was tired and even angry.
Your love and encouragement made this dissertation into what it is today.

I look forward to raising our young lady, Mackenzie.
With your encouragement, I know she will have the confidence to be a scientist.

You, Mackenzie, and Cooper have been my cheerleaders.
This is for you.

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CHAPTER ONE

INTRODUCTION

Statement of the Problem

We exist and proliferate in a period of time dominated by innovation. A quick perusal of periodicals reveals ever-changing advances in medicine, technology, scientific research, and engineering. The best and the brightest scientists, doctors, researchers, and engineers continually advance our society through collaboration, cooperation, and competition. As the demographics in the United States change, along with educational policy and research, it is important now more than ever for policymakers and stakeholders to consider ways to further expose children in the United States to the STEM fields (science, technology, engineering, and math). In fact, many states included STEM education as a facet of their Race to the Top applications in addition to making heavy investments in STEM education as a means of educational improvement (Johnson, 2012).

It is necessary for all of our children to gain exposure and experience in STEM fields, especially children showing an interest early on in their academic careers. However, it is not enough to teach STEM during science class or in the context of the conventional school day. Learning opportunities for the interested children must extend beyond the school day. Exposure and experience in STEM fields, even through informal, out-of-school times promote sustained interest and can even increase achievement in fields related to the topic, such as science and math (McNally, 2012). Research illustrates a need to prepare generations of competent professionals capable of working in STEM fields and cooperate, collaborate, and compete with young professionals throughout the world ("Increasing the Number of STEM Graduates," 2010). These trends in the employment market launch discussions regarding the need for policymakers and educators to offer more preparation in STEM to our children. These discussions developed into urgent action items as the results from PISA 2006 revealed an international achievement gap between the U.S. and other nations (both developed and developing) in science and mathematics (International Center for Educational Statistics [ICES], 2007).

This achievement gap creates tension for the economy as well. To put it bluntly, the United States fails to produce the amount of domestic graduates needed to meet the national demand for employment, which forces companies to hire international candidates. Employment data released by the National Science Foundation (NSF) provide optimism for recent and future college graduates with STEM degrees, because the demand for employment in these fields are higher than other occupations (NSF, 2011a). The United States is simply not producing enough college graduates to gain employment in these fields.

National policymakers used Race to the Top as a means to encourage states to lead the way in educational reform by requiring STEM initiatives in the application process to help combat these statistics (Johnson, 2012). Though several states were not awarded funds through Race to the Top, the finalists—including Arizona—were encouraged in continuing their mission of educational reform through STEM education with round three funding (United States Department of Education, 2011). This issue echoes in the message of the Executive Office of the United States Government as well. President Obama emphasized the need for educational reform through STEM initiatives and insisted that schools would be rewarded for building partnerships and classes that focus on STEM (Obama, 2013b). The importance for schools to provide authentic learning opportunities in STEM is clear. These opportunities afford elementary and secondary students exposure and experience to cultivate their interests in these subjects.

Unfortunately, schools are faced with barriers to offering innovative programs that can keep children, especially girls, on the STEM pipeline throughout their academic careers. STEM education is often limited due to lack of funding, partnership, expertise and planning time (Williams, 2011). These barriers often cause schools to provide ineffective programming, which could limit the impact or even deter students from entering the STEM fields. In many cases, schools stick to current curricula and do not offer STEM programs at all. In order for educators to positively impact student achievement and build an interest in children to pursue the STEM pipeline, schools must circumnavigate these barriers and offer high quality STEM programming ((“Increasing the Number of STEM Graduates,” 2010).

Further confounding the issue of the gap in enrollment in STEM pipeline courses lags in the United States is the issue of gender equity in STEM. Girls are underrepresented in STEM pathways in college and women are an extreme minority in the STEM workforce. According to statistics from the U.S. Department of Commerce, Economics and Statistics Administration (2011), in 2009, women accounted for just 24% of engineers and scientists. An increase in representation of women in STEM career pathways would help lead to an increase in the number of Americans in the STEM talent pool; however, this increase would explicitly offer a more varied perspective that would possibly influence breakthroughs in science, technology, and engineering. The societal impact of involving more women in STEM fields includes more people gaining from their perspective that specifically helps to improve feminine-driven issues, such as specifically targeting matters in women's health, in addition to helping the United States to globally compete in STEM innovations (Milgram, 2011; Obama, The White House, 2013a).

Purpose of the Study

The purpose of this quantitative study was to examine the impact of the length of engagement in after-school learning opportunities in STEM education on middle school girls (Grades 6-8) in an affluent suburban elementary school district in the southwestern United States. The after-school learning opportunities come in the form of carefully designed 6 to 8 week courses emphasizing in authentic learning experiences and problem-based learning modules designed to approach practical scientific problems utilizing the engineering design method. The majority of the programs fuse each of the elements of STEM (science, technology, engineering and mathematics) in the program through its activities and experiences.

These programs have been offered at each of the middle school sites in the Desert Willow School District. Any student interested in registering for the course at that site was able to participate. The programs drew more than 500 children into the out-of-school STEM learning opportunities from 2010-2012. Because the programs were offered over a period of time and many of the experiences rotated between sites, many children chose to enroll in more than one experience over time. This resulted in some students enrolling in up to four experiences over the period of time that the after-school learning experiences were offered. An ethnically diverse group of boys and girls from all schools participated in these programs throughout the school district. This study aims to examine how the after-school STEM programs of the Desert Willow School District affected the female students enrolling in one or more than one of the programs.

Table 1

The After-School STEM Programs Offered by the Desert Willow School District and the Element of STEM, the Program Covered by the Programs

Title of out-of school program	Science	Technology	Engineering	Math
Alternative Energy	X	X	X	X
Bioengineering: Designing the Artificial Heart	X	X	X	X
Energy	X	X	X	X
Energy Meets Biology	X	X	X	X
Engineering	X	X	X	X
Exploration of Dynamic Earth	X	X		X
Genetics and Neuroscience	X	X	X	X
Girls in Engineering	X	X	X	X
Human-Climate Interactions	X	X		X
Life 101: What makes an Alien	X	X	X	X
Microbiology	X	X	X	X
Neuromuscular Control and Prosthetic Design	X	X	X	X
Urban Ecology	X	X	X	X
Water Meets Energy	X	X	X	X
Water Works	X	X	X	X

Research Questions

This study addresses the following research questions:

1. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their confidence in their science and math abilities?
2. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their interest in attaining a career in the STEM fields?
3. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their interest in math and science classes?
4. How does length of engagement (participation in a single or more than one after-school program) of female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect the female participants' views towards gender parity in STEM careers?

Significance of the Study

The work of closing the gender gap in the STEM workforce begins in middle school. Schools looking to circumvent the barriers associated with implementing effective and sustainable after-school STEM programs must consider how to attract students to participate in more than one after-school program while preparing participants for possible career pathways in STEM. Furthermore, schools must continue to consider that learning is not an isolated event that occurs in a classroom with a whiteboard and science kits. Learning must occur across contexts and extend outside classroom walls.

Schools continuously seek enriching experiences to offer children opportunities to pursue their interests and increase academic achievement. The Desert Willow School District, similarly to other districts, accomplishes this by offering children opportunities to explore the STEM fields in an out-of-school environment, by offering learning opportunities such as prosthetics design, alternative energy, human-climate interactions, microbiology, and urban ecology. The goal of these programs and comparable programs in other districts is to satiate the interests of eager students aiming for careers in the STEM fields by cultivating a child's passions for exploration by integrating the Engineering Design Process, which is a defined as a process similar to the design process used by actual engineers to find solutions to practical problems.

Similar to the scientific method, the engineering design process begins the process of stating a problem, researching the problem, and generating possible ideas towards a solution. Selecting a possible solution and then following through with the construction of the solution in order to test and evaluate it follow this step. Once the solution is tested, the results are communicated and the solution can be redesigned. This flexible method varies depending on the publisher of the process. The image describing the engineering design process in Figure 1 is a simple and original reproduction integrating the perspectives of Hynes (2012) and the diagram utilized by NASA for educating elementary-aged students (NASA, 2008).

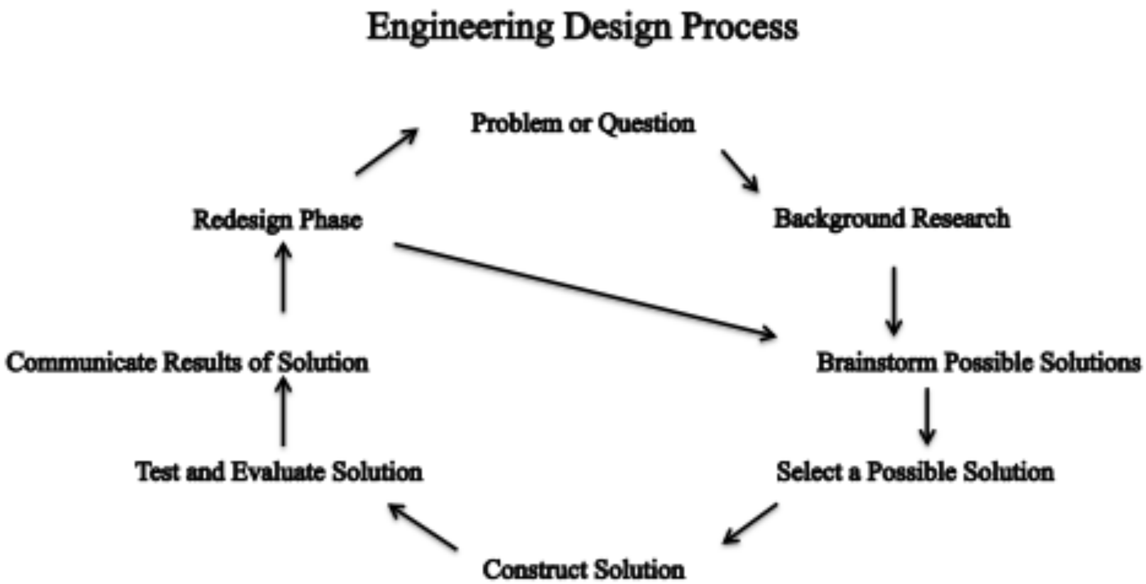

Figure 1. The engineering design process

This study is significant as it reveals the growing demand for effective and high quality after-school programming emphasizing in STEM education, in addition to the global economic need to generate and sustain the interest of a child choosing a career pathway in a STEM field. This global economic need divulges the issue of equity in these fields. Women are underrepresented in the STEM fields beyond high school.

Encouraging learning in an out-of-school setting is a critical component to a child's motivation to learn and gain confidence in a content area. Expanding learning during a child's discretionary time outside of the school day affords a child the opportunity of exploring interests that are likely to extend into their future academic pathways and career choices. Inspecting out-of-school learning as a critical component of a child's Learning Ecology (Barron, 2006) provides educators and scholars with a framework to realize the importance of learning during this discretionary time. An after-school STEM program serves as an important context of learning for children and can impact a children's interest and confidence as they forge ahead to make decisions about their academics and careers.

It is important for researchers and educators to better understand how after-school STEM programs offered by schools can impact children. Increasing the motivation and offering additional quality experiences for children to pursue STEM careers may help fulfill the national demand for a qualified STEM workforce, while closing the gender gap in STEM employment.

Delimitations

The students participating in this study enrolled in the after-school programs from October 2010 through April 2012. The data were collected in the summer and fall of 2013. The Desert Willow School District, a large suburban elementary school district in the southwestern United States, is the location of the study. The study included the middle school girls participating in the after-school STEM programs while in middle school (Grades 6-8). The study included students who met this study's criteria for selection. The criteria for selection were female students engaging in one or more than one of the after-school STEM programs offered by the school district.

Assumptions

This study included the following assumptions:

1. The students examined in this study can remember what their perceptions were of the after-school STEM programs.

2. Survey responses from the participants accurately reflect their perceptions, openly and honestly.

Definition of Terms

After-school program. Activities or organized programs held outside of the traditional school day. Youth engage in these programs in a variety of settings. In the case of this study, after-school programs occurred at the child's school.

Authentic learning experiences/opportunities. An authentic learning experience is a learning experience that engages a child in a practical or real-life scientific, technological, engineering, or mathematical problem. Likely, an authentic experience will integrate several or all dimensions of STEM.

Engineering design process. The method used to guide engineers from problem to solution (Hynes, 2012). The students engaging in the after-school programs use a process similar to actual engineers and scientists.

Learning ecology perspective. The conceptual notion that learning is distributed throughout multiple settings, community, peer interactions, home, and school (Barron, 2006). In this study, after-school programs were framed as an integral portion of a child's learning ecology, which formulates a child's overall educational progress.

Length of engagement. The number of after-school programs a child participated in: a single program, subsequent programs, or more than one program.

STEM. An acronym used for the fields of study including science, technology, engineering, and mathematics. In terms of this study, STEM refers to the enhancement of one or more dimensions of this acronym, due to the integration of all of the fields of study.

Summary

The impetus for economic change in the United States is to produce more STEM graduates from American colleges and universities to compete with other nations. Our schools play an important role in this economic framework, especially in preparing women, who are underrepresented in the STEM workforce. Our schools need to work innovatively to ensure girls continue to engage in the STEM pipeline from middle school to the workforce. This study investigated the impact the length of engagement in after-school STEM programs had on middle school girls.

The following chapter of this study explores the literature related to the impact of STEM learning opportunities outside of the classroom, while the subsequent chapter delineates the research design and methodology utilized to explore the impact after-school STEM programs have on girls. Chapter 4 presents an analysis of the data and the findings. Chapter 5 presents the summary, conclusions, and recommendations based on the findings of the impact the length of engagement in after-school STEM programs have on middle school girls.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

The focus of this literature review is the importance of after-school STEM programs in K-12 education. After-school STEM programs are much like other after-school learning opportunities and activities, in that they occur outside of the formal school day, they feed a specific need or interest, and they complement the learning that occurs during formal school time. Schools offer programs due to high parent and/or student demand to curb behavior by providing a sense of belonging or to engage students in an enriching or supplementary activity. Regardless of the reasons for offering after-school programs, a plethora of opportunities are available for students in middle school. Because after-school STEM opportunities hold so many implications for the future of after-school activities, this section begins by reviewing literature concerning the social and academic importance of after-school programs.

The depth and range of topics offered in after-school STEM programs vary depending on the population they serve, in particular depending on age. Because this study focused on middle school in particular, a focus on the progression of after-school programs through the echelons of academia is presented. This section is concluded by an examination of the literature considering effects of after-school STEM programs on girls, because this study considered gender as a possible variable in the effects of participating in subsequent after-school STEM programs over time.

It is important to restate the purpose of this study to frame the importance of the aforementioned topics to be investigated. The purpose of this quantitative study was to examine the impact of participating in more than one after-school learning opportunities in STEM education on middle school girls (Grades 6-8) in an affluent suburban elementary school district in the southwestern United States.

Although the participation of women in STEM fields has been on the rise in recent years, the issue of gender parity remains a hindrance to an equitable workforce. The gender gap still exists, while the number of women choosing to pursue college coursework and careers in STEM lags in comparison to other industries (National Science Foundation, 2011b). Educational researchers are aware of this problem and exude the importance of closing the gender gap by increasing the quantity of female college graduates with STEM degrees (Farenga & Joyce, 1999; Koenig, 2008; Milgram, 2011; Oakes, 1990).

After-school Programs

After-school learning opportunities represent an important component of the educational experience for many children in the United States. The history of after-school programs date back to more than a century in the history of American schools and is rooted in societal changes of the time. A decrease in the need for child labor and the birth of compulsory education prolonged the amount of free time for children (Halpern, 2002). The first organized after-school programs formed during the late 19th century in the form of “boy’s clubs,” which served as centers for children in highly urbanized areas, boys in particular, to attend structured activities during after school hours (Mahoney 2005). The origins of after-school programs were not isolated to disadvantaged youth in highly urban areas. Rural agricultural programs such as 4-H have roots as far back as 1900, when children in rural communities participated in agricultural after-school clubs to participate in creative, hands-on agricultural experiments, such as growing corn in different soil types (4-History, 2013). As time progressed, rates of single-parent families, dual-parent employment, and changes in urban American neighborhoods occurred. Neighborhoods becoming less and less safe for children to play while unsupervised increased the demand for structured and safe options after school (Mahoney, 2005). It is out of this demand that the importance for high quality after-school programs was born.

After-school programs offer children an extension to their learning day and offer high quality programs that are a valuable portion of a child's overall education and social development (Junge, 2003). Today, after-school programs still provide a safe and structured place for children to stay; however, after-school programs now have a noteworthy academic focus as well. After-school programs with an academic focus aim to improve academic performance in a content area either through extension or intervention. In a study conducted by Black, Doolittle, Zhu, Unterman, and Grossman (2008), after-school math intervention aiming to help students who were performing below grade level and math enrichment aiming to help students who were at or above grade level, improved the academic performance of elementary school students on standardized tests within the first year of implementation. The academic achievement increases for children enrolled in after-school programs compared to those who care for themselves or who are cared for by a sibling after-school, especially children in impoverished areas (Mahoney, 2005). Gifted and talented children benefit from a sense of higher academic achievement as well. In a study conducted by Reis and Boeve (2009), children identified as gifted and talented were able to gain a higher level of achievement in reading later in life when enrolled in an after-school reading enrichment program.

Children enrolled in after-school academic programs benefit on standardized tests as well as in the classroom.

Today, schools present children with a variety of academic and social activities and it is very common for parents to enroll their child in an activity of some sort that extends beyond the school day. Parents enrolling their children in after-school programs trust that educational organizations are providing high quality informal learning experiences beyond their child's school day. According to data collected by the United States Department of Health and Human Services Administration for Children and Families (2010), as many as 8.4 million of the nearly 32 million children aged 5 to 12 are enrolled in a range of before- or after-school programs. This represents 26% of the national student population aged 5-12 that is enrolled in some sort of after-school program that benefit them socially, behaviorally or academically.

The After-school Alliance (2010) estimated 16% of K to 12 children in Arizona participate in some sort of after-school program. These data also show that 34% of all Arizona K to 12 children would likely participate in an after-school program if high quality programs were made available in their community. Though accessibility to high quality programs presents a barrier to enrollment in after-school programs, it is clear that after-school programs service a sizeable portion of the K to 12 children in Arizona and across the nation.

High quality after-school activities serve as an important catalyst for engaging students in topics of interest to them, and they serve as an intervention or prevention for socially risky behavior. Children who engage in a high quality after-school program are less likely to engage in activities such as drug, alcohol, and tobacco use (Arizona After

School Alliance, 2010). The children enrolled in programs find other activities to occupy their time. Parents, especially single parents or working parents, enroll their children in after-school programs at school or a community center to prevent their children from being exposed to negative neighborhood influences, risky childhood behavior, or inactivity that influences negative behavior in their children. Children find a sense of purpose and diverge from risky behavior associated with lack of supervision or unstructured activity out-of school (Halpern, 2002).

Parental demand for high quality after-school programs is echoed by parental support for these programs. A survey conducted by the United States Department of Education (2000) illustrated that almost nearly 100% of adults agreed that after-school programs are important to help children develop academic and social skills in a safe and caring environment (Chung, 2000). A report on the after-school programs by Rogers, Godard, Shafer, and Fields (2009) in San Francisco supports that parental demand for high quality after-school programs in public schools remains high. This study illustrates the demand for parents enrolling their children in public school to extend learning in some fashion after the school day, but also illustrates the importance of after-school programs presence in a community. Though these two studies support the claim that after-school programs are in high demand and parents are generally satisfied, more research is needed to illustrate specifically what types of programs parents demand.

Learning Ecology Perspective

In a pinnacle examination of interest in learning, Brigid Barron (2006) utilized the perspective of learning ecologies to frame the concept that learning occurs in a variety of contexts. Conceptualizing that interest-driven learning experiences are self-sustaining, students experience heightened achievement and confidence in subjects related to their interests by pursuing learning during their discretionary time after an interest develops in any number of contexts: in the classroom, at home, or even during informal play with their friends. The Learning Ecology Perspective has value in studying the impact of after-school STEM programs, because a great deal of child's learning occurs in and out of school and that these perceived separate contexts of learning are interrelated and lead to students to synthesize and edify their learning.

Allowing students to explore their interests through multiple contexts leads to these interests and competencies becoming self-sustaining and developing into areas of expertise later in life (Barron, 2004, 2006). After-school programs are excellent sources to generate and foster interest for students showing an early desire to pursue their interests in a particular subject. Particularly in the middle grades, the learning that occurs within these programs impact student achievement and interest and may affect the decisions of students to pursue their interests and build upon their competencies when they are in high school and beyond (Black et al., 2008; Halpern, 2002; Junge, 2003).

Barron (2004, 2006) stated that the overall experience of participating in after-school programs differs greatly from the formal pedagogical practices during the school day. In this manner, after-school learning experiences enhance classroom instruction and lead to higher achievement in school for the participants. The students involved in learning opportunities to pursue their interests during their discretionary time can experience success in the classroom in their areas of interest and in related fields. In terms of after-school STEM programs, this postulates that a child can participate in a program about sustainable energy sources or artificial limbs and experience an increase in interest in their math and science classes in school. The students' interests lead to increased confidence and competency in various subjects associated with the programs. In these programs, children are exposed to the unique opportunities, not typically encountered in the classroom, that enrich and nurture the learners' interests to become a STEM professional. Students are able to explore topics beyond the science curriculum that foster their interests and tap their areas of expertise, improving self-confidence, which impacts achievement in and out of the classroom (Hollister, 2003). Figure 2 below outlines the major assumptions of the Learning Ecology Perspective provided by Barron (2006).

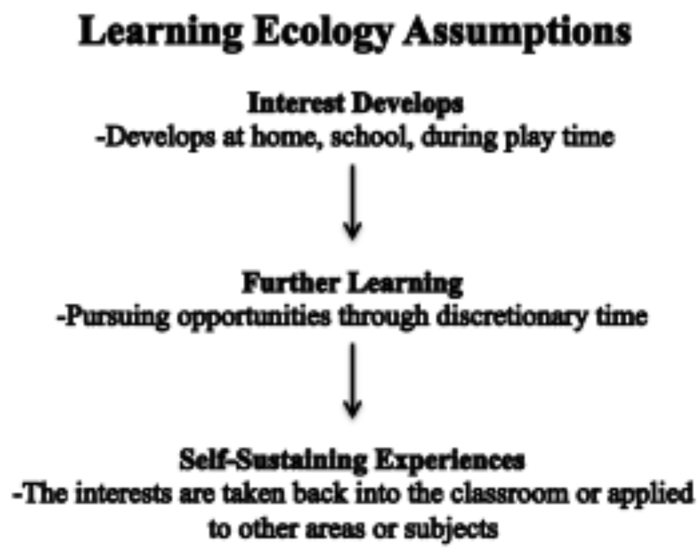

Figure 2. Learning ecology assumptions

Interest: The Goal of After-School Programs

After-school learning opportunities take place outside of formal instructional time and away from the context of an academic classroom. This learning occurs during a child's discretionary time outside of the school day, which benefits the learner in many ways. Children opt into out-of-school learning experiences on their own will or with the guidance of their parents. Because these experiences are typically not obligatory, instead at the discretion of the child, they serve the interests of children (Luehmann, 2009). Informal after-school learning typically emphasizes experiential and inquiry-based-learning opportunities, highlighting peer-to-peer interaction, straying away from traditional pedagogical practices in the classroom (Crane, Nicholson, Chen, & Bitgood, 1994). After-school programs play an important role in helping young people explore and build their interests. As mentioned earlier, children enter after-school programs for a variety of reasons; however, no matter what type of activity children engage in, it is a great opportunity for them to explore and build upon their interests. Whether a child is trying an activity for the first time or has been re-enrolled in the same program for several years, after-school programs develop a child's interest in the activity.

A high quality program allows students to build connections and relationships with other students and adult professionals in an informal learning environment and allows for the child to take responsibility of their own learning. This furnishes an environment where motivation to learn is higher and more connected to their interests (Nugent, Barker, Grandgenett, & Adamchuk, 2010). Fashioning motivation to learn by building social connections with their peers and adult professionals leads to an increase in confidence by helping children develop new skills that emphasize higher orders of thinking, ingenuity, design, and innovation (Nugent et al., 2010). Scholars argue that these connections increase student interest and improve competency in the topics they study (Tracey, 2002; Tracey & Ward, 1998). Building motivation, in addition to reinforcing skills through intervention and extension, allows children to flourish.

The social connections that after-school programs foster produce the confidence children need to succeed in their area of study. In this context, the construction of social capital leads to confidence in the arena of the learning experience. Social capital, a resource produced through relationships and connections to help students accomplish their academic goals in and out of the classroom (Bourdieu, 1986; Erickson, 1996), helps to increase the confidence of the participants. Children benefit academically and socially from the increase in confidence through the construction of social capital that is instilled in after-school programs. Children forge new social networks, learn the tools real scientists and engineers use, and increase their technological competency in the area they study. Children are exposed to a simulated work place by utilizing social networks such as gaining group membership and reciprocity, engagement, organizational participation, and collegiality (Junge, 2003; Putnam, 2000). This allows us to conceptualize how after-school programs affect a child's interest, how children engage in their interests, and whether or not children continue their engagement in their interests.

Progression of STEM Pathway Through After-School Learning

Children participate in a number of changes in interest throughout their academic careers. This refers to their educational "pathway," how children indulge in their academic interests over the course of their academic career. Children can explore the STEM pathway by supplementing their learning through after-school STEM activities throughout the duration of their academic careers. Because a child's academic career can span more than 12 years (including pre-school), a child is exposed to different levels of after-school activities.

Pre-Kindergarten and Elementary (K-5)

A child's first experience with after-school programs may occur as early as pre-kindergarten and may involve a child playing with objects or experimenting with simple materials. In elementary school, the focus of after-school programs is two-fold: First, to generate excitement and, second, provide a safe and structured environment for children as an alternative to unsupervised time (Marshall, 2010; Varney, Aslam, & Graham, 2012). Though academic and social purposes exist in after-school STEM programs, at all levels, the social purpose remains stagnant (Marshall, 2009).

The academic purpose of after-school STEM program in elementary schools seems to focus on generating excitement in children to become aware and become interested in STEM topics (Varney, Aslam, & Graham, 2012). In a study by Tyler-Wood, Ellison, Lim, and Periathiruvadi, 2012), excitement increased through exposure to the authentic STEM tasks of the program. The study also showed that confidence and student achievement increased as a result of STEM programs focused on elementary school girls. This study illustrates the importance of generating an interest for children in out-of-school environments during the elementary years.

Middle School (6-8)

While in elementary school, children gain excitement for topics through after-school STEM programs, the focus in middle school shifts slightly to aim at increasing a child's perception of competency and interest in pursuing STEM as a career. Stohlmann, Moore, McClelland, and Roehrig (2011) found that middle school students engaged in a STEM curriculum benefited by learning the skills utilized by STEM professionals through enjoyable hands-on activities. This study showed that students in middle school can generate interest in a topic while practicing the skills they could use in the workforce, such as 3-D modeling, prototype fabrication, and problem solving through a process similar to the engineering design process. Verma, Dickerson, and McKinney (2011) found that while student content knowledge can increase, the perceived competency, or confidence of students can increase while engaging in a STEM project-based learning activity. This study showed that providing children with open-ended problems and opportunities to think creatively and collaborate with their peers allows children to enjoy a learning experience and build confidence. Confidence and interest at this age are crucial due to the timing.

In middle schools, children are not yet bound to a career pathway through course selection of high school and have not yet chosen a college or declared a major. Tracey (1998) and Tracey and Ward (2002) showed that the middle school years (Grades 6 to 8) are the most critical in forming and shaping a child's confidence or self-efficacy and interest. By participating in realistic STEM activities, children are able to build interest, confidence, and practical skills associated with the STEM disciplines to choose a career pathway.

High School (9-12)

The research of Tracey (1998) and Tracey and Ward (2002) displayed that by the time a child exits middle school, their perceptions on competency and interest are set. Further research shows that by the time a child reaches high school, children, especially girls, have already lost interest in science and math, which also lends to poor representation of women in STEM disciplines in college and careers (Farenga & Joyce, 1999).

By the time a child enters high school, he or she choose coursework to pursue a perspective pathway of interest for college or career readiness. Children staying the pathway in STEM will choose courses in the disciplines and likely participate in supplemental after-school programs in the discipline. Children enrolled in after-school programs to supplement their interests and competencies are more likely to graduate from high school, enroll in a four-year university, and study a STEM discipline (Lyon, Jafri, & St. Louis, 2012). Koenig (2008) reinforced the notion that attaining interest and competency in middle school directly affects these children when they enter high school. Though this study focused on girls in science (GIS), middle school girls improved their competency and interest in science through experiences such as field trips and participating in project-based learning. This research suggests that interest and competency must be instilled in children, especially girls, for them to be more likely to choose a STEM pathway in high school.

To sum up this subsection, the academic underachievement of girls does not explain the gender gap in STEM fields. In the K-12 context, the performance of girls in math shows that they in some cases outperform their male counterparts. Girls are performing well in mathematics, yet equity in STEM employment still exists (Riegle-Crumb, King, Grodsky, & Muller, 2012). Koenig (2008) reminded us that the practical problem of the participation of women in STEM fields is deeply rooted in K through 12 education, in particular in the middle school years when girls typically leave the STEM pathway due lack of interest, confidence, and a lack of exposure to gender-similar role models to build a positive scientific or engineering identity.

The Components of a Successful After-School STEM Program

After-school learning opportunities provide students a safe environment to establish social relationships for children with their fellow peers in addition to adults. A child can greatly benefit while participating in after-school programs. A child's experiences have a positive impact on achievement in school; and though it is not an emphasis in this dissertation, after-school learning has a great impact on the achievement of marginalized student populations (Hollister, 2003).

Program Leadership/Mentorship

One factor for a successful, high quality after-school program is the leadership in the program. Involving teachers or even university volunteers to teach young people can positively affect the children within the program. According to Bruce, Bruce, Conrad, and Hui-Ju (1997), the presence of university science students affects the attitudes and interest of elementary children in an after-school science program by providing them with positive images of a scientist as a role model figure. Whether they are university students, teachers, or even competent and experienced students, program leaders execute important tasks within after-school programs, including facilitation, mentorship, and providing positive images of people working in the fields of study. Mentoring leaders empower children to succeed by increasing student interest and confidence (Clark & Sheridan, 2010). Mentors play an important role in the overall well being of a child and play an important role in the development of interests through building of confidence (Schwartz, Lowe, & Rhodes, 2012). Mentors for children in after-school STEM programs serve as critical builders of confidence and interest for the children involved in after-school programs. The confidence that mentors bring to a child functions as a significant factor in children choosing STEM as a career (Redmond, et al 2011). The increase in confidence is especially observable in girls enrolled in after-school STEM programs when personal relationships are initiated and sustained through a mentor/mentee relationship (Chun & Harris, 2011; Redmond et al., 2011). A mentor's influence in building motivation and interest toward concepts in STEM also enforces a child's deeper overall learning and understanding of STEM concepts.

The mentoring and leadership component in an after-school program encompassing STEM topics benefits a child in and out of school. In a sizeable analysis examining LA's BEST after-school science programs, Huang and colleagues (2007) found that children enrolled in after-school science programs succeeded in both academic and non-academic areas largely due to the mentoring component of the program. The adolescents engaged in the program experienced higher test scores and grades while they were in school. Furthermore, they accrued fewer disciplinary contacts than other students while working closely with other adolescents and the adult leaders in the program.

Students enrolled in a high quality after-school STEM or STEM-like program gain and maintain a high level of interest in school. Children typically experience an increase in competency in the subjects they study within their after-school program. In the case of LA's BEST, an after-school program was offered as an important component of a child's learning ecology, because it extended the learning in an out-of-school context. The interdependency of each component in after-school programs (leadership/mentorship, engagement in authentic tasks, and confidence) support the children involved.

Interest

The academic and behavioral successes of children enrolled in after-school STEM programs are interdependent on engaging children in authentic STEM tasks. Authentic tasks provide children with realistic and positive images of STEM professions through problem-based learning activities, which have the ability to motivate students and increase their confidence and interest in the topics they study (Freeman, Alston, Winborne, 2008; Fusco, 2001; Hussar, Schwartz, Boilselle, & Noam, 2008). Encouraging children to engage in solving a practical problem just as real scientists and engineers provides them with realistic skills that a scientist or engineer would use in the field. Utilizing these scientific and engineering skills to solve problems can lead to an increase in specific content knowledge and achievement, such as the citizen scientist project on bird biology posed by Brossard (2005).

The effects of engaging children in authentic STEM tasks are presented in a study of the FIRST robotics program by Welch and Huffman (2011) who determined that engaging students in genuine scientific and engineering problems through after-school programs can lead to improvements in a child's attitude towards science. This study reinforced the idea that high quality after-school programs, such as robotics and engineering, can lead to improving students' attitudes and generating higher interest in science and engineering-related fields.

Confidence

Another factor that affects the success of an after-school STEM program is self-efficacy or confidence upon entering and exiting the program. The dynamics of student confidence are complex and need to be considered when studying the impact of any after-school program. Confidence takes into account a child's perception of his or her ability to succeed at a task or subject. Bandura, Barbaranelli, Caprara, and Pastorelli (2001) explained that a child's perceived confidence emerges as a result of interaction between several elements, including familial factors and socio-economic status.

Confidence in terms of children's sense of believing that they are good at a subject can shape their career efficacy. Tai, Liu, Maltese, and Fan (2006) indicated the confidence of students who are high achievers in math impacts the probability of their achieving a degree in STEM fields. This research noted that students who envision a career in science are more likely to attain a career in science than children who are high achievers in math and do not expect to enter science as a career. Academic identity takes career expectation into account more so than achievement in a subject. After-school STEM programs naturally incorporate expectations of STEM careers, as they require students to participate in authentic tasks related to a scientific or engineering problem (Brossard, 2005).

Increasing confidence in girls while in middle school is critical to the success that girls may experience later in their pathway towards a STEM career. Providing quality mentor/mentee relationships or images of female scientists and engineers in after-school STEM programs is one way to increase the confidence and self-efficacy of young girls. Research shows this leads to an increased confidence by allowing girls to build a positive STEM identity—they can view themselves as scientists (Chun & Harris, 2011; Tyler-Wood et al., 2012). When an after-school program incorporates strategies to help girls be successful, the likelihood of the girls staying on the STEM pathway into high school through college increases. After-school STEM programs offer girls the capacity to build an identity as a STEM professional and deepens their interests in the topics they yearn to study as an important component of a child's learning ecology.

Summary

After-school programs have long been an important component of the learning ecology of children. After-school programs have an important role at satiating interests and confidence in the children enrolled in them. The purpose of after-school programs varies throughout the years a child is in school, generating excitement in elementary school, building interest and confidence in middle school, while supplementing coursework in high school.

In this regard, after-school STEM programs in middle school seek to increase student interest and confidence students feel towards STEM, in hopes of sustaining their pathway on the STEM pipeline. It is clear through the research that girls are more likely to leave the STEM pathway than boys, thus resulting in the gender gap existing in the innovative workforce today. It is important to reinforce the confidence and allow girls to generate interest in science, technology, engineering, and math throughout their middle school years in order to help close the gender gap in participation in STEM fields. To accomplish this, it is important to further our understanding of middle school girls' participation in after-school STEM programs over time.

CHAPTER THREE

METHODOLOGY

Introduction

The purpose of this chapter is to outline how the research questions associated with this study were investigated. A presentation of the quantitative survey method utilized in this study is presented, followed by a thorough description of this study's population and sample. This is followed with a summary of procedures for sampling and an outline of the instrument that was utilized to collect data. This chapter concludes with procedures for collecting and analyzing data along with a presentation of the limitations of this study.

Statement of Purpose

The purpose of this quantitative study was to examine the impact of the length of engagement in after-school learning opportunities in STEM education on middle school girls (Grades 6 to 8) in an affluent suburban elementary school district in the southwestern United States. Length of engagement is defined in this study as the number of after-school programs a child participated in: a single program, subsequent programs, or more than one program.

Research Questions

This study addressed the following research questions:

1. How does length of engagement (participation in a single or more than one after-school programs) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their confidence in their science and math abilities?

2. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their interest in attaining a career in the STEM fields?
3. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their interest math and science classes?
4. How does length of engagement (participation in a single or more than one after-school program) of female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect the female participants' views towards gender parity in STEM careers?

Research Design

In examining the attitudes, interests, or perceived confidence of a population, a survey design provides a quantitative description from which generalizations of a population can be made (Creswell, 2009). The intent of this study was to investigate the impact of the after-school STEM programs offered by the Desert Willow School District. A survey design methodology provides descriptive and inferential data to test the research questions associated with this study.

In this study, the length of time the female students spent in the after-school programs is examined. Some girls participated in just one after-school program and others re-enrolled in more than one program over time. The length of participation, through single enrollment or re-enrollment in numerous subsequent programs, was investigated for effects on a mixture of concepts: interest in attaining a career in STEM, interest in science and math classes, confidence in abilities in STEM subjects, and gender parity. A survey design method may contribute to the understanding of the effects of single enrollment in a program or re-enrollment in several programs over time on these concepts in this context and these results may have implications to other educational contexts as well.

Population and Sample

The Desert Willow School District contains 25 total schools, including six middle schools (Grades 6 to 8) with an enrollment of approximately 5,500 children. The school district is quite affluent geographically and high achieving, ranking in the top 25 in its state's accountability rating system. The school district contains no middle schools receiving federal funding under the Title 1 program for school improvement.

From the fall of 2010 through the spring of 2012, 557 male and female middle school students engaged in after-school STEM programs in the Desert Willow School District. This represents nearly 10% of the nearly 5,500 children enrolled in the entire Desert Willow School District. The after-school programs offered by the school district were widely representative of all of the fields in STEM. Table 2 presents the after-school programs offered in the Desert Willow School District, including the elements of STEM that each program included.

Table 2

The After-School STEM Programs Offered by the Desert Willow School District and the Element of STEM Included

Title of out-of school program	Science	Technology	Engineering	Math
Alternative Energy	X	X	X	X
Bioengineering: Designing the Artificial Heart	X	X	X	X
Energy	X	X	X	X
Energy Meets Biology	X	X	X	X
Engineering	X	X	X	X
Exploration of Dynamic Earth	X	X		X
Genetics and Neuroscience	X	X	X	X
Girls in Engineering	X	X	X	X
Human-Climate Interactions	X	X		X
Life 101: What makes an Alien	X	X	X	X
Microbiology	X	X	X	X
Neuromuscular Control and Prosthetic Design	X	X	X	X
Urban Ecology	X	X	X	X
Water Meets Energy	X	X	X	X
Water Works	X	X	X	X

Of the 557 children enrolled in an after-school STEM program, approximately 250 girls were enrolled. The after-school programs engaged 86 girls of those children in more than one after-school program, which accounts for approximately 34% of the girls engaged in the STEM programs offered by the district. The 86 girls account for approximately 2% of the middle school girls enrolled in the Desert Willow School District. Because the emphasis of this study focused on the importance of increasing the participation of women in the STEM fields, the sample for this study focused solely on the female participants. At the time of their respective enrollment the students were middle school students (Grades 6 to 8) and, for the purpose of the connection to the literature, assumed to be between ages of 11 and 14 years.

Contact information was available for 198 of the 250 girls who participated in at least one after-school program. A survey (Appendix A) was sent to all 198 girls with available contact information (email addresses were the contact information available for this study). Ideally, a response rate with comparable participants enrolled in a single program and participants enrolled in more than one program would respond to the survey. Because this survey was voluntary and non-incentivized, the expected response rate was lower than 60%, which would be fewer than 118 respondents.

Survey Instrument

A copy of the survey instrument utilized in this study is in Appendix A, and a copy of the cover letter accompanying the survey instrument is in Appendix B. This survey instrument was developed to answer the research questions associated with this study. It contains 24 items in total, which is an appropriate length for middle school-aged students. The questions were written in age-appropriate language and vocabulary. Five questions on the survey include questions that confirm the gender of the student, identifies the current grade level, and asks for the number of programs in which they were enrolled.

The first 19 questions on the survey were rated by a Likert scale that reflected an element relating to the research questions for this study: confidence in their science and math abilities, interest in attaining a career in the STEM fields, interest in science and math classes, and views on gender parity in STEM. The first 19 survey items were rated by the following Likert-scale selections: *strongly agree, agree, neutral, disagree,* and *strongly disagree*.

Question 20 rated the students' attitudes towards the likelihood of attaining a college degree in a STEM topic: *very likely, likely, undecided, unlikely, very likely*, and *very unlikely*. In addition, the survey also contained items (Questions 21 through 24) measured with a scale based on the work of Wilbur Brookover (1962) to measure the confidence students have in their math and science abilities compared to their peers. These survey items were rated on the following scale: *I am the best; I am above average; I am average; I am below average;* and *I am the poorest*.

The survey instrument utilized negatively worded items to improve the reliability by eliminating guessing on certain items. The survey instrument begins with descriptive questions to confirm gender, gather information for length of engagement in the after-school STEM programs, and current grade level. This allowed for the disaggregation of data when it was analyzed.

As a variable, examined by the survey, *single enrollment and re-enrollment* over time refers to the number of programs a student participated in while registered in the Desert Willow School District. Many students only participated in one after-school program; however, several students re-enrolled in the programs for a second term and some enrolled for up to four terms, while they were offered by the school district.

The following topics organized the discussion of the results to see if the length of time the students spent in after-school STEM programs impacted the attitudes towards interest and confidence:

Interest: Interest is investigated through questions regarding enjoyment and interest in future career plans in each of the STEM field. The survey instrument also explores interest in math and science classes.

Confidence: Confidence is investigated through questions probing how the STEM programs affected their performance in science and math classes. Confidence is also measured in terms of their confidence in their abilities in science and math compared to their close friends.

Gender Parity: This concept is investigated through questions probing which gender the girls viewed as being more likely to pursue a career in each of the STEM fields.

Data Collection Procedures

Prior to commencing this study, permission **(**Appendix C**)** from the Office of the Superintendent and the Executive Director of Curriculum and Learning Services of the Desert Willow School District was necessary to ensure the privacy of the school district and the privacy of the students who participated in the programs. The approval **(**Appendix D**)** of the Institutional Review Board of Arizona State University was also necessary to further ensure the privacy of the participants and that academic integrity was maintained throughout the process of this study. These approvals are present in the appendices (Appendices C and D) of this study, with any identifying names or descriptions redacted.

Once the survey instrument was approved, the instrument was distributed through a web-based survey design interface (Surveymonkey). The survey was activated and distributed to the email recipients over the summer and fall of 2013. The approximated survey time per participant was 20 minutes. To ensure the survey participants that their results would remain confidential, a statement of confidentiality was issued at the launch of the survey, including an explicit statement that the survey would not collect or report any identifying information, including ethnicity or names (Appendix B).

The data for this study were collected over the summer and fall of 2013 through an online survey design interface, Surveymonkey. The data were collected through this portal and exported to Microsoft Excel where it was sorted and prepared for analysis. A summary report of the sorted data is present in the appendices of this study (Appendix E). The voluntary survey invitation was sent to 198 female participants in these after-school STEM programs. The email invitations were sent out in a formal and professionally composed email (Appendix B).

Data Analysis

The data from the female respondents for this study were exported to Microsoft Excel. Descriptive statistics, including means and standard deviations, were calculated for each item exploring interest, confidence, and views on gender parity. These results were disaggregated by the length of participation in the after-school STEM programs, single program participation, and more-than-one-program participation, to examine the impact of the length of time in the after-school STEM program on the girls' attitudes towards interest in attaining a career in STEM, confidence in math and science, and views towards parity in STEM careers.

These items were further examined through an independent samples *t* test for female students participating in a single after-school STEM program versus female students participating in more than one after-school STEM program. Effect size for each of these calculations were measured with Cohen's *D* to reveal statistical significance of the findings. In Chapter 4, these results are presented briefly in narratives that are further depicted by data tables.

Limitations

The major limitation of this study was the population from which the sample of this study was drawn. Of the approximated 5,500 middle school students enrolled in the entire Desert Willow School District, only 557 participated in any of the after-school STEM programs between 2010-2012. Approximately 250 of the after-school STEM program participants were girls. This population was comprised of 198 girls with available contact information to actually survey. The survey invitation was formally sent to all 198 girls and 26 email addresses were returned immediately as invalid addresses, bringing the total population that the survey was issued to down to 176 possible participants. A total of 58 females responded to the survey, yielding a response rate of 33%, which was expected at the launch of this study, because the survey was involuntary and non-incentivized.

A limitation of this study was the relatively small size of the response rate. This methodology yielded 58 female participant responses to the survey, which is minute in comparison to the 557 male and female participants enrolled in the after-school programs; however, when compared to the 176 girls participating in an after-school STEM program with valid contact information, the sample was suitable for this study.

The data collection may have yielded a relatively low response rate; however, the average response rate for studies that utilize data collected voluntarily from organizational studies average at 35.7%; and email surveys, similar to the methodology of this study, typically produce an average lower, but are considered the scholarly average for such studies (Baruch & Holtom, 2008). In this study, the response rate was low, but within one standard deviation of similar voluntary, non-incentive organizational studies.

CHAPTER FOUR

RESULTS

Introduction

This chapter presents the results of the survey implemented to investigate the research questions of this study. As stated in Chapter 1, this study examines the differences between girls enrolled in a single after-school STEM program and girls enrolled in more than one in the after-school STEM programs offered by the Desert Willow School District. The chapter is organized in terms of the specific research questions posed in Chapter 1, which are restated in the next paragraph.

Research Questions

Three research questions were investigated to better understand the impact of after-school STEM (science, technology, engineering and mathematics) programs on middle school girls. Specifically, by using the collected data through survey responses, the researcher conducted different levels to analyze the following:

1. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their confidence in their science and math abilities?
2. How does length of engagement (participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their interest in attaining a career in the STEM fields?

3. How does length of engagement (Participation in a single or more than one after-school program) of the female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect their interest math and science classes?
4. How does length of engagement (participation in a single or more than one after-school program) of female middle school participants in the after-school STEM programs offered by the Desert Willow School District affect the female participants' views towards gender parity in STEM careers?

Demographics

The total female sample population for this study included 58 female students ($n = 58$). The aggregate of female students participating in one of the after-school STEM programs in the Desert Willow School District was 35 ($n = 35$), and 23 ($n = 23$) female students participated in more than one of the after-school STEM programs.

At the time of the implementation of this survey, the data revealed that the girls were either enrolled in middle school or high school. The sample included 13 high school girls (Grades 9 to 12) and 45 middle school girls (Grades 6 to 8). It is important to again note that each of the students in this sample was enrolled in middle school (Grades 6 to 8) when they participated in the after-school STEM programs.

As iterated previously in this study, the respondents were not asked to identify their race/ethnicity for this survey, as the topic of race/ethnicity is beyond the scope of the research questions associated with this study. Thus, demographic data regarding race was not included as part of this study.

Tables 3 and 4 display the statistics regarding the length of participation in the after-school STEM programs offered by the Desert Willow School District.

Table 3

Frequency and Percentage of Girls Enrolled in a Single After-School STEM Program and Girls Participating in More Than One After-School STEM Program

Length of participation	*n*	% of total female sample
Single after-school program participation	35	60.3
Multiple after-school program participation	23	40.7

Table 4

Frequency and Percentage of Girls Enrolled in a Single After-School STEM Program and Girls Participating in More Than One After-School STEM Program.

Length of participation	*n*	% of total female sample
1	35	60.3
2	14	24.1
3	3	0.05
4	6	10.3

In this section, the descriptive statistics for each the female students enrolled in a single after-school STEM program are presented. This presentation is followed by descriptive statistics for the female students participating in more than one of the after-school STEM programs. The results are presented as they relate to the research questions for this study:

1. Confidence in science and math abilities
2. Interest in attaining a career in STEM
3. Interest in science and math classes
4. Views towards gender parity in the STEM fields

Many of the questions on the survey utilized a Likert Scale, while some utilized a scale based on the work of Wilbur Brookover (1962) to measure confidence in abilities. The descriptive statistics for the research questions were assigned numerical value to determine statistical significance between the groups of students: students participating in a single after-school STEM program and students participating in more than one after-school STEM program.

For the sake of presenting the data in a manner that is easy to read, the following abbreviations were utilized when referring to statistics:

n = raw number of responses received by the survey participants

M = Mean of the responses

SD = Standard deviation of the responses

Descriptive Statistics for Girls Enrolled in a Single After-School STEM program: Confidence in Science and Math Abilities

The results measuring the confidence in science and math classes are presented in this section. In general, the female participants enrolled in a single after-school program responded positively to the questions regarding confidence in science, and responded fairly confident in terms of their confidence in math classes, indicating that the after-school programs positively impacted their ability to do well in science and math. Tables 5 through 8 show the means and standard deviations of the questions with alignment to the research questions.

Table 5

Frequency of Responses, Means, and Standard Deviations of Questions 1 Through 6: Female Participants Enrolled in a Single After-School Program

	Q1: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my science classes.	Q2: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my math classes.	Q3: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my science classes.	Q4: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my math classes.	Q5: After participating in the after-school STEM program at my school, I DO NOT feel confident that I can do well in my science classes.	Q6: After participating in the after-school STEM program at my school, I do not feel confident that I can do well in my math classes.
Strongly agree	10	6	14	6	0	0
Agree	15	9	13	13	3	0
Neutral	10	20	6	10	0	4
Disagree	0	0	2	6	12	14
Strongly disagree	0	0	0	0	20	15
Mean	4	3.6	4.11	3.54	1.6	1.88
SD	0.75	0.76	0.88	0.96	0.86	0.91

In addition to questioning the program participants on a Likert-scale, the survey instrument also investigated research questions related to confidence with items utilizing a scale based on Wilbur Brookover's self-efficacy and abilities instrument (1962). These inquiries targeted the students' perceived confidence in their abilities in science and math compared to their peers. The girls participating in a single after-school STEM program scored high with a mean of 4.17 on the item concerning science and moderately high with a mean of 3.79 on the item concerning math.

Table 6

Frequency of Responses, Means, and Standard Deviations of Questions 21 Through 24: Girls Enrolled in One After-School STEM Program: Confidence in Science and Math Classes (Brookover Scale)

	Q21: After participating in the after-school STEM program at my school, how do you rate yourself in on your abilities in science compared with your close friends	Q22: After participating in the after-school STEM program at my school, how do you rate yourself on your abilities in math compared with your close friends	Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.
Best, strongly agree	8	6	2
Above	25	16	27
Average	2	13	6
Below average	0	0	0
Worst	0	0	0
Mean	4.17	3.79	3.88
SD	0.51	0.71	0.47

Table 7

Frequency of Responses, Means, and Standard Deviations of Questions 23 and 24: Girls Enrolled in One After-School STEM Program: Confidence in Science and Math Classes (Brookover Scale)

	Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.	Q24: Comparing yourself to your close friends how would you rate yourself in having the mathematical skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.
Best, strongly agree	2	5
Above	27	18
Average	6	10
Below average	0	2
Worst	0	0
Mean	3.88	3.73
SD	0.47	0.77

Descriptive Statistics for Girls Enrolled in a Single After-School STEM Program: Interest in Pursuing a Career in STEM

Table 8 displays the responses for the survey items examining interest in the students pursuing a career in STEM. The girls enrolled in one after-school STEM program to these questions generally responded moderately in their interest in pursuing a career in STEM. The frequency of responses, the means, and standard deviations are presented in Table 8.

Table 8

Frequency of Responses, Means, and Standard Deviations of Questions 7 Through 10: Girls Enrolled in One After-School STEM Program: Interest in Pursuing a Career in STEM

	Q7: After participating in the after-school STEM program at my school, I wanted to have a career in mathematics.	Q8: After participating in the after-school STEM program at my school, I wanted to have a career in engineering.	Q9: After participating in the after-school STEM program at my school, I wanted to have a career in science.	Q10: After participating in the after-school STEM program at my school, I wanted to have a career in technology.
Strongly agree	0	8	6	1
Agree	9	4	13	11
Neutral	8	10	8	11
Disagree	16	10	8	10
Strongly disagree	2	3	0	2
Mean	2.69	3.06	3.49	2.97
SD	0.91	1.31	1.02	0.97

Table 9 displays the responses for the items examining the confidence of the students involved in the after-school programs in pursuing a career in one of the STEM fields. Overall, the girls enrolled in one after-school STEM program generally responded high in their confidence in completing the coursework in college necessary to pursue a career in a STEM field. The female students enrolled in a single program of the programs responded with a mean of 4.29 with a standard deviation of 0.667.

Table 9

Frequency of Responses, Means, and Standard Deviations of Question 20: Girls Enrolled in One After-school STEM program: Confidence in Abilities in STEM

	Q20: In order to become a scientist or engineer, at least four years of college is necessary. After participating in the after-school STEM programs at my school, how likely are you to complete such advanced work?
Best/strongly agree	14
Above average/agree	17
Average/neutral	4
Below average/disagree	0
Worst/strongly disagree	0
Response average	4.29
Standard deviation	0.66

Descriptive Statistics for Girls Participating in More Than One After-School Program: Interest in Science and Math Classes

Table 10 displays the results for the items examining the topic of how the after-school STEM programs affected the interest of the participants in their science and math classes. The questions in this portion of the survey utilized the traditional Likert scale.

Table 10

Frequency of Responses, Means, and Standard Deviations of Questions 11 and 12: Girls Enrolled in One After-School STEM Program: Interest in Science and Math Classes

	Question 11: The after-school STEM Program I participated in made me more interested in my science classes.	Question 12: The after-school STEM program I participated in made me more interested in my math classes
Strongly agree	10	0
Agree	15	6
Neutral	10	16
Disagree	0	9
Strongly disagree	0	4
Response average	4	2.68
Standard deviation	0.75	0.88

Descriptive Statistics for Girls Enrolled in a Single After-school STEM Programs: Gender Parity in STEM Fields

Table 11 displays the results for the items examining the topic of parity in the STEM fields. Each question asks for the perceptions of the girls on who is likely to have a career in STEM, boys or girls. The responses to these questions were answered on a Likert scale.

Table 11

Frequency of Responses, Means, and Standard Deviations of Questions 16 Through 19: Girls Enrolled in One After-school STEM Program: Parity in STEM Careers

	Question 16: Boys are more likely to have a career as a scientist than girls.	Question 17: Boys are more likely to have a career as an engineer than girls.	Question 18: Boys are more likely to have a career in technology than girls	Question 19: Boys are more likely to have a career in mathematics than girls.
Strongly agree	4	6	4	2
Agree	4	4	8	2
Neutral	4	6	3	7
Disagree	14	12	11	14
Strongly disagree	9	7	9	10
Response average	2.47	2.76	2.67	2.23
Standard deviation	1.28	1.35	1.36	1.08

Descriptive Statistics of Girls Enrolled in More than One After-school STEM Program: Confidence in Science and Math Classes

This section provides a presentation of descriptive statistics for each the female students participating in more than one of the after-school programs. Similarly to the previously presented data, this section outlines the findings by the research question associated with this study.

The descriptive results measuring the confidence in science and math classes are illustrated in Table 12. Remarkably, the female participants enrolled in more than one after-school STEM program responded positively to the questions regarding confidence in science and fairly confident as to their math classes, indicating that the after-school programs positively impacted their ability to do well in science and math classes.

Table 12

Frequency of Responses, Means, and Standard Deviations of Questions 1 Through 6: Girls Enrolled in More Than One After-School STEM Program: Confidence in Science and Math Classes

	Q1: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my science classes.	Q2: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my math classes.	Q3: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my science classes.	Q4: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my math classes.	Q5: After participating in the after-school STEM program at my school, I DO NOT feel confident that I can do well in my science classes.	Q 6: After participating in the after-school STEM program at my school, I do not feel confident that I can do well in my math classes.
Strongly agree	10	4	8	6	0	2
Agree	6	8	10	4	0	0
Neutral	7	9	5	9	1	1
Disagree	0	2	0	4	6	5
Strongly disagree	0	0	0	0	16	15
Mean	4.13	3.6	4.13	3.52	1.34	1.7
SD	0.84	0.87	0.74	1.05	0.56	1.15

Supplemental to this set of questions was a set of survey items based upon Brookover's self-concept and abilities scale to measure academic abilities in math classes and science classes. The item targeting the students' perceived confidence in their abilities in science revealed high results for the girls participating in more than one of the after-school programs with a mean of 4.04. The items targeting math revealed high ability as well, with a mean of 4.00 (Table 13).

Table 13

Frequency of Responses, Means, and Standard Deviations of Questions 21 through 23: Girls Enrolled in More Than One After-School STEM Program: Confidence in Science and Math Classes (Brookover Scale)

	Q21: After participating in the after-school STEM program at my school, how do you rate yourself in on your abilities in science compared with your close friends	Q22: After participating in the after-school STEM program at my school, how do you rate yourself on your abilities in math compared with your close friends?	Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.
Best	5	9	6
Above	13	7	12
Average	5	5	3
Below average	0	2	2
Worst	0	0	0
Mean	4	4.04	3.96
SD	0.6	0.97	0.624

Table 14 displays the responses for the survey items examining the confidence of their abilities in science and math. The girls enrolled in more than one after-school STEM program responded high, displaying confidence in their abilities in science and math, which are necessary to pursue a career in the STEM fields. The girls responded in regards to science with a mean of 3.96. These girls noted slightly lower, but still moderately high abilities in math to earn a college degree in STEM with a mean of 3.8.

Table 14

Frequency of Responses, Means, and Standard Deviations of Questions 23 and 24: Girls Enrolled in More Than One After-School STEM Program: Confidence in Science and Math Classes (Brookover Scale)

	Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.	Q24: Comparing yourself to your close friends how would you rate yourself in having the mathematical skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.
Best/strongly agree	6	8
Above average/agree	12	6
Average/neutral	3	9
Below average/ disagree	2	0
Worst/strongly disagree	0	0
Response average	4	3.8
Standard deviation	0.88	0.83

Descriptive Statistics for Girls Participating in More Than One After-School Program: Interest in Pursuing a Career in STEM

Table 15 displays the responses for the items examining interest in the students pursuing a career in STEM. The female students participating in more than one of the after-school STEM programs responded remarkably high in their interest in pursuing a career in the STEM fields, except for mathematics. The female students enrolled in more than one of the programs responded with a mean of 3.09 to attain a career in mathematics, a mean of 4.22 to attain a career in engineering, a mean of 4.29 to attain a career in science and a mean of 3.52 to attain a career in technology.

Table 15

Frequency of Responses, Means, and Standard Deviations of Questions 7 Through 10: Girls Enrolled in More Than One After-School STEM Program: Interest in Pursuing a Career in STEM

	Q7: After participating in the after-school STEM program at my school, I wanted to have a career in mathematics.	Q8: After participating in the after-school STEM program at my school, I wanted to have a career in engineering.	Q9: After participating in the after-school STEM program at my school, I wanted to have a career in science.	Q10: After participating in the after-school STEM program at my school, I wanted to have a career in technology
Strongly agree	2	12	8	2
Agree	6	4	14	8
Neutral	9	7	1	13
Disagree	4	0	0	0
Strongly disagree	2	0	0	0
Mean	3.09	4.22	4.29	3.52
SD	1.05	0.88	0.54	0.65

Descriptive Statistics for Girls Participating in More Than One After-School Program: Career in STEM

The next item focuses on the likelihood that the student will pursue a career in STEM. The female students enrolled in more than one of the programs responded with a mean of 4.58. These results are reported in Table 16.

Table 16

Frequency of Responses, Mean, and Standard Deviation of Question 20: Girls Enrolled in More Than One After-School STEM Program: Confidence in Pursuing a Career in STEM

	Q20: In order to become a scientist or engineer, at least four years of college is necessary. After participating in the after-school STEM programs at my school, how likely are you to complete such advanced work?
Best/strongly agree	16
Above average/agree	4
Average/neutral	3
Below average/disagree	0
Worst/strongly disagree	0
Response average	4.58
Standard deviation	0.71

Descriptive Statistics for Girls Participating in More Than One After-School Program: Interest in Science and Math Classes

Table 17 displays the results for the item examining the topic of how the after-school STEM programs affected the interest of the participants in their science and math classes. The questions in this portion of the survey utilized the traditional Likert scale.

Table 17

Frequency of Responses, Means, and Standard Deviations of Questions 11 and 12: Girls Enrolled in More Than One After-School STEM Program: Interest in Science and Math Classes

	Question 11: The after-school STEM program I participated in made me more interested in my science classes.	Question 12: The after-school STEM program I participated in made me more interested in my math classes.
Strongly agree	8	4
Agree	8	4
Neutral	7	11
Disagree	0	4
Strongly disagree	0	0
Response average	4.04	3.34
Standard deviation	0.8	0.96

Descriptive Statistics for Girls Participating in More Than One After-school Program: Gender Parity in STEM

Table 18 displays the results for the items examining the topic of parity in the STEM fields. Each question asks for the perceptions of the girls on who is likely to have a career in STEM, boys or girls. The responses to these questions were answered on a Likert scale.

Table 18

Frequency of Responses, Means, and Standard Deviations of Questions 16 Through 19: Girls Enrolled in More Than One After-School STEM Program: Parity in STEM Careers

	Question 16: Boys are more likely to have a career as a scientist than girls.	Question 17: Boys are more likely to have a career as an engineer than girls	Question 18: Boys are more likely to have a career in technology than girls	Question 19: Boys are more likely to have a career in mathematics than girls.
Strongly agree	0	0	0	0
Agree	3	4	4	6
Neutral	7	8	8	6
Disagree	8	6	6	6
Strongly disagree	5	5	5	5
Response average	2.43	2.47	2.47	2.5
Standard deviation	0.97	1.01	1.01	1.07

Statistical Significance: *t* Test for Independent Samples

This section examines the differences between the female students participating in a single program versus those participating in more than one of the after-school STEM programs in the Desert Willow School District. This section allows the research questions to be further explored. The results for the tests for statistical significance and effect size are unfolded according to the following research questions:

1. Confidence in science and math abilities
2. Interest in attaining a career in STEM
3. Interest in science and math classes

4. Views towards gender parity in the STEM fields

For the sake of brevity and understanding the data presented in this section, girls participating in one after-school program are referred to as “Single Program” and girls participating in more than one after-school program are referred to as “Multiple Programs.”

Statistical significance is defined as the following:

* = $p < 0.05$

**= $p < 0.01$

Confidence in Science and Math Abilities

This section examined the differences in confidence in science and math classes among the female students participating in the after-school STEM programs. The survey inventory contained six items examining the confidence of the students’ abilities in their science and math classes.

This analysis focused on those students’ perspectives of their current perceptions of confidence after participating in one or more than one after-school experience in STEM. Confidence in math and science were selected from the survey inventory to analyze. Questions 1, 3, and 5 inquired directly and positively to examine the concept of confidence in science and math while Questions 2, 4, and 6 were posed in a negative frame. Tables 19 and 20 show the outcomes of the independent samples *t* test to examine the difference. The purpose of using the *t* test for independent samples was to examine the differences of two separate groups: girls enrolled in a single program and girls participating in more than one after-school STEM program. Tables 19 and 20 below summarize the results for these tests.

Table 19

Results of the t Test for Independent Samples for Student Confidence in Science Classes

	Single program			Multiple programs					
Survey Item	*Mean*	*SD*	*N*	*Mean*	*S.*	*N*	*t*-value	*df*	Sig.
Q1: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my science classes.	4	0.767	35	4.13	0.869	23	-0.601	56	0.55
Q3: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my science classes.	4.11	0.9	35	4.13	0.757	23	-0.071	56	0.944
Q5: After participating in the after-school STEM program at my school, I DO NOT feel confident that I can do well in my science classes	1.6	0.881	35	1.35	0.573	23	1.21	56	0.23

Table 20

Results of the t Test for Independent Samples for Student Confidence in Math Classes

	Single program			Multiple programs					
Survey Item	*Mean*	*SD*	*N*	*Mean*	*S.*	*N*	*t*-value	*df*	Sig.
Q2: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my math classes.	3.6	0.775	35	3.61	0.891	23	-0.039	56	0.969
Q4: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my math classes.	3.54	0.98	35	3.52	1.08	23	0.077	56	.939
Q6: After participating in the after-school STEM program at my school, I do not feel confident that I can do well in my math classes.	1.67	0.692	33	1.67	1.17	23	0	55	1

Interest in Pursuing a STEM Career

This section examines the differences in interest in attaining a career in each of the STEM fields. The survey inventory contained four items examining this concept, outlining interest in attaining a career in one of the STEM fields.

This analysis focused on the perceptions of the respondents' interest in attaining a career in a STEM field after participating in one or more than one after-school experiences in STEM. This measure looks at the perception of interest in pursing a career in science, technology, engineering and mathematics. Questions 7-10 inquired these concepts directly. Table 21 shows the outcome of the independent samples *t* test to examine the difference between girls enrolled in a single program or in more than one after-school STEM program.

Table 21

Results From t Test of Independent Samples for Interest of Female Students in Attaining a Career in STEM

	Girls enrolled in a single program			Multiple programs					
Survey Item	*M*	*SD*	*N*	*M*	*SD*	*N*	*t*-value	*df*	Sig.
Q7: After participating in the after-school STEM program at my school, I wanted to have a career in mathematics.	2.69	0.932	35	3.09	1.08	23	-1.5	56	0.138
Q8: After participating in the after-school STEM program at my school, I wanted to have a career in engineering.	3.06	1.33	35	4.22	0.902	23	-3.68	57	0.001**
Q9: After participating in the after-school STEM program at my school, I wanted to have a career in science.	3.49	1.04	35	4.29	0.55	23	-3.865	54.10	0.001**

Table 21 (continued)

Results From t Test of Independent Samples for Interest of Female Students in Attaining a Career in STEM

Q10: After participating in the after-school STEM program at my school, I wanted to have a career in technology.	2.97	0.985	35	3.52	0.665	23	-2.35	56	0.022*

The survey inventory contained three items examining the topic of the students' perceived abilities, if they will complete a STEM degree in college in order to pursue a STEM career. This analysis concentrated on the perceptions of the respondents' current abilities in attaining a career in STEM after participating in one or more than one after-school experience in STEM. This measure looked at the perceptions of their abilities in math and science in order to complete a degree in STEM and attain a career in a STEM field. Questions 20, 23 and 24 inquired these topics directly. Table 22 presents the outcome of the independent samples *t* test to examine the difference between single program participants and girls enrolled in more than one after-school STEM program.

Table 22

Results From t Test of Independent Samples for Likelihood of Completing an Advanced Degree and Attaining a Career in STEM

	Single program			Multiple programs					
Survey Item	*M*	*SD*	*N*	*Mean*	*SD*	*N*	*t*-value	*df*	Sig.
Q20: In order to become a scientist or engineer, at least four years of college is necessary. After participating in the after-school STEM programs at my school, how likely are you to complete such advanced work?	4.29	0.667	35	4.58	0.717	23	-1.63	57	0.108

Table 22 (continued)

Results From t Test of Independent Samples for Likelihood of Completing an Advanced Degree and Attaining a Career in STEM

Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.	3.89	0.471	35	3.96	0.878	23	-0.399	56	0.692
Q24: Comparing yourself to your close friends how would you rate yourself in having the mathematical skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.	3.74	0.78	35	3.8	0.834	20	-0.255	53	0.8

Interest in Science and Math Classes

The survey instrument contained questions examining the interest in math and science classes after participating in the after-school STEM programs. Table 23 below presents the outcome of the independent samples *t* test to examine the difference between girls enrolled in one program and girls enrolled in more than one after-school STEM program. The effect size is significant at $p < 0.05$.

Table 23

Results From t Test Of Independent Samples for Interest in Science and Math Classes

Survey Item	Single program			Multiple programs					
	M	*SD*	*N*	*M*	*SD*	*N*	*t*-value	*df*	Sig.
Q11: The after-school STEM program I participated in made me more interested in my science classes.	4	0.767	35	4.04	0.825	23	–0.205	56	0.838
Q12: The after-school STEM program I participated in made me more interested in my math classes.	2.69	0.9	35	3.35	0.982	23	–2.64	56	0.011*

Parity in STEM Careers

The survey instrument contained a series of questions examining the perceptions of how the girls viewed gender parity in the STEM fields. The girls were asked if boys were more likely than them to attain a career in STEM. Table 24 presents the outcome of the independent samples *t* test to examine the difference between girls enrolled in one program and girls enrolled in more than one after-school STEM program.

Table 24

Results From t Test of Independent Samples for Parity in Each of the Attaining Careers in Each of the STEM Fields

	Single program			Multiple programs					.
Survey Item	*M*	*SD*	*N*	*M*	*SD*	*N*	*t*-value	*df*	Sig.
Q16: Boys are more likely to have a career as a scientist than girls.	2.43	1.313	35	2.35	0.982	23	0.252	56	0.802
Q17: Boys are more likely to have a career as an engineer than girls	2.71	1.384	35	2.48	1.04	23	0.698	56	0.488
Q18: Boys are more likely to have a career in technology than girls	2.63	1.395	35	2.48	1.04	23	0.442	56	0.66
Q19: Boys are more likely to have a career in mathematics than girls.	2.2	1.106	35	2.57	1.12	23	-1.22	56	0.226

Summary

Descriptive statistics and demographic data were utilized for the female participants in this study. The results from independent samples *t* tests of the females enrolled in a single program versus females enrolled in more than one program revealed the differences between female respondents participating enrolled in a single program and those participating in more than one of the after-school STEM programs in the Desert Willow School District. The results explained the impact of the after-school STEM programs on student confidence and interest in the core classes of science and math and pursuing a career in STEM. The conclusions and major implications based on the results presented are discussed in the final chapter of this study.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter presents a summary of the study that is comprised of important conclusions pertaining to the need for effective after-school STEM programs in middle schools drawn from the data presented in Chapter 4. This chapter provides a thorough discussion of the practical implications of this study by presenting a case for after-school programs emphasizing the STEM fields. The limitations of this study and recommendations for future research conclude this chapter.

Summary of the Study

This study investigated the impact of after-school learning opportunities in STEM education on middle school aged children in an affluent suburban district, the Desert Willow School District. In particular, this study focused on the impact in terms of enrollment as to the confidence and interest female students had on STEM. The study took place in a medium-sized suburban school district in the Southwest Desert District offering after-school STEM programs ranging in topics from sustainability to prosthetics.

Overview of the Problem

Currently, schools are challenged to inspire our children to pursue and achieve degrees and careers in STEM ((“Increasing the Number of STEM Graduates,” 2010; Johnson, 2012). Inspiring our youth to pursue advanced degrees that can translate into careers in the STEM fields requires schools to win the confidence of children by offering solid exposure to the curricula necessary to pursue an advanced degree in STEM, but also provide them with engaging real-world experiences to spurn their interests in science, technology, engineering, and mathematics.

Engaging children in STEM can occur in and out of school. Research shows that out-of-school experiences can help children ignite their interests and instill confidence in STEM by providing them with real-world experiences in the fields. Igniting interest in the middle level allows children to maintain an interest in pursuing upper-level science and math coursework, which Sadler, Sonnert, Hazari, and Tai (2014) argued increases STEM career interest in high school. The importance of igniting interest occurs well before a child enters high school. Unlike situational interest, individual interest includes more than just a passing positive affect toward science, but the development of long-term feelings, information, and values that encourages further thinking and taking part in science (Hidi & Renninger, 2006).

Schools must overcome barriers and obstacles mentioned by Johnson (2012) in order to increase interest and confidence among children when they become adults to participate in the STEM fields. Increasing interest and confidence in the STEM fields impacts student achievement and closes the employment gap in the STEM fields (Tan, Calabrese Barton, Hosun, & O'Neill, 2013). It is very important for schools to engage children in middle school because this is where aptitudes and interest in career fields are forged (Barron, 2006). Thusly, schools are challenged with promoting STEM opportunities to interest children at the middle school level.

Purpose Statement and Research Questions

The purpose of this quantitative study was to examine the impact of terms of engagement in after-school learning opportunities in STEM education on middle school female students (Grades 6 to 8) in an affluent suburban elementary school district in the southwestern United States.

In this study, three research questions were investigated to better understand the impact of after-school STEM (science, technology, engineering and mathematics) programs on middle school students. Specifically, by using the collected data through survey responses, the researcher conducted different levels of statistical analysis to reveal the following:

1. How did terms of engagement (single-term versus multiple terms) in the after-school STEM programs offered by Desert Willow School District affect the confidence of female students in their science and math classes?
2. How did terms of engagement (single-term versus multiple terms) in the after-school STEM programs offered by Desert Willow School District affect the confidence of female students in a STEM career?
3. How did terms of engagement (single-term versus multiple terms) in the after-school STEM programs offered by Desert Willow School District affect the interest of female students in their pursuit of a STEM career?

Major Findings

The major findings of this survey are presented in this section. The findings are accompanied with an emphasis on how the findings relate to the literature, including a comparison of similarities and differences between this study and previous studies. The section is concluded with a presentation of unanticipated outcomes of this study.

Broadly stated, an analysis of the data shows that female students participating in the multiple term after-school STEM program reported significantly higher interest in pursuing a career in three of the four STEM areas: engineering, science, and technology. Additionally, an analysis of the data shows no statistical significance in regards to the concepts of confidence or abilities in the STEM fields or the perception of the role that gender plays in attaining a STEM career.

Interest in Pursuing STEM Career

These findings indicate that overall the females participating in multiple terms of the STEM programs at their school show more interest at pursuing a career in the fields of engineering, science, and technology. Though the findings for interest in pursuing a career related to math did not reach statistical significance, the interest of female participants enrolling in multiple terms was still higher than that of single-term female participants. Interestingly, the findings revealed multiple-term female participants showed more interest in their math classes at school as a result of the after-school STEM program than single-term female participants. These findings are evident when comparing single-term females ($M = 2.69$, $SD = .90$) to multiple-term females ($M = 3.35$, $SD = .982$), $t(56) = -2.64$, $p = .011$ (two-tailed). The Cohen's d indicated a medium effect size, at .71. This indicates that though the girls participating in multiple terms of the program had a mild, but not statistically significant interest in pursuing a career related to mathematics, they did show more interest in their math classes at school.

These findings provided support for the impact of after-school STEM programs. Clearly, the female students who participated in more than one term of the program expressed a heightened interest in pursuing a career in science, technology, and engineering. Multiple terms of engagement positively impacted the girls who participated in the program. This complements the findings in similar studies, such as Stake and

Mares (2001), who found that science enrichment programs benefited adolescents, especially girls. Their findings highlighted the exposure of the multiple aspects of an enrichment program, similar to those in this study, including the influence of positive leaders and hands-on, authentic science activities positively impacting the girls by increasing their commitment in pursuing a career in science.

The findings in this study also supported the findings of Atwater, Colson, and Simpson (1999), who found that an out-of-school science-focused program reinforces the intentions of students planning on majoring in a science or related field in college. Furthermore, Luehmann (2009) and Gibson and Chase (2002) noted the positive impact of out-of-school science programs on adolescents' interest in pursuing a career in a STEM field.

Confidence in Math and Science Abilities

The lack of a difference as to confidence in math and science abilities is related to the literature in this area. Although there is no difference between single and multiple terms of engagement in the programs, both groups show that the girls involved in the programs have a high overall confidence in math and science. Stake and Mare (2001) found that in addition to the increased interest in fields related to science, adolescents also experienced an increased confidence as their abilities in these areas. They also found that high confidence in science was an important factor in relation to interest in pursuing a career in science.

Perceptions on the Role of Gender in STEM Careers

The results suggested that the girls in the program viewed girls as fairly equivalent to boys in terms of likelihood of attaining a career in STEM. No significant differences were noted in regards to the amount of terms of participation, suggesting that girls participating in one term and girls participating in more than one term correspondingly considered girls were just as likely as boys to attain a career in STEM. The results for the perceptions of the role of gender in the area of attaining a career in STEM were noteworthy when considering the existing body of literature on this topic. The literature revealed that girls participating in science programs outside of school were more likely to promote interest and generate the confidence necessary to tackle the rigor of pursuing career in STEM (Gibson & Chase, 2002; Luehmann, 2009; Stake & Mares, 2001). Moreover, the girls participating voluntarily in out-of-school STEM experiences typically were high-achieving students and were typically interested in STEM. These girls need to be encouraged by participating in authentic and equitable STEM opportunities outside of the classroom where their work is recognized in order to strengthen their vigorous engagement and continue in the STEM pipeline (Tan et al., 2013).

Conclusions

Brigid Barron's (2004) conjectures of the learning ecology perspective, previously cited in this study, provided a valuable framework to illuminate the impact of the after-school STEM learning experiences explored in this study. First, an interest, such as a topic related to STEM, is generated in various contexts, such as at home, school, or even informal playtime with friends. Next, opportunities to further explore an interest are utilized. This could include learning during a child's discretionary time, such as pursuing structured learning opportunities (e.g., after-school STEM programs). This is an opportunity for a child to pursue opportunities related to his or her authentic learning opportunities outside of the school day. Finally, these learning activities based on interest become a self-sustaining part of the child's educational identity.

Although some girls may have entered the after-school programs with a prior interest in STEM that developed at home, in school, or even among informal interactions with their friends, it is clear that the girls in the program displayed an interest in STEM while participating in the programs. Regardless of the genesis of the interest, the first conjecture is assumed for all of the participants in this study.

The after-school programs exist as the quantum vehicle, representing the second conjecture. The after-school programs occur during the discretionary time of the girls; and during these programs, they were able to explore their interests through authentic learning opportunities. The effects of the programs offer compelling evidence that girls enrolled in multiple terms of an after-school program exhibit an interest in pursuing a STEM career. Experiencing science and engineering in a nurturing culture where they are able to use the tools used in the fields of study with positive adult mentorship and guidance allows the girls' interests to radiate.

The third conjecture relates to the girls enrolled in multiple terms of the programs demonstrated a higher likelihood of their displaying an interest in their math courses, showing that participating in learning activities related to their topic of interest crosses the boundary of school and out-of-school learning. The girls showing more interest in their math class signifies that their interest provides a lens to see math as more useful toward their practice and allows them a see a practical purpose for their math classes.

Overall, the after-school programs appeared to be an effective catalyst to maintain the interest of girls pursuing STEM-related careers while in middle school, in addition to allowing their interest in a topic to provide a new lens for the way they see their work during school. The implications of these conclusions are critical to this discussion. The impact of after-school STEM programs in schools likely have systemic implications for the retention of girls along the STEM pipeline.

Implications for Action

The implications of this study provide educators with a reassurance that effective after-school STEM programs can help encourage and retain girls to remain in the pipeline through the middle years. This study revealed implications for the inclusion of effective out-of-school STEM learning opportunities in the extracurricular offerings at all schools. Furthermore, this study reinforces the need for policy at the national level to provide funding for STEM in K through 12 public schools as part of a plan to tackle the issue of gender parity in the STEM workforce. These aforementioned implications drawn from this study are explored further in this section.

Implications for Out-of-School Stem in Local Schools

Schools push to involve students in out-of-school activities for various reasons. However, schools face many barriers, such as budgeting concerns and finding staff as program sponsors; however, it is crucial for schools to expand their repertoire of extracurricular activities to include effective STEM programs for students. Sustainable programs that kids can enroll in for multiple terms can impact a school campus by increasing student interest in math classes and interest in attaining a career in STEM fields.

Even with ever-changing legislation schools are continually held accountable for student learning, especially in math. Adding a STEM program after-school can increase student interest in the subject of math. In the classroom, students are often not exposed to practical purposes of equations and algorithms they utilize to learn math for a period of 45 to 60 minutes daily. In an out-of-school learning environment, kids have the chance to partake in activities to use math in a practical sense that helps them realize the usefulness of their learning. Increasing interest in math could possibly correlate with better student achievement in the subject as well.

Increasing student interest in the STEM fields, similarly, could likely associate with increased student achievement. Students are driven to perform when they are interested in the subject. If students are particularly interested in a field, they are likely to perform better in those classes. A limitation to this is curriculum taught in the context of the classroom should also be engaging, relevant, and include opportunities to participate in authentic STEM activities.

Effective after-school STEM programs have the potential to help schools increase student achievement by increasing the level of interest that students experience while in the program. To accomplish this, schools must also provide students with engaging and enriching experiences in the classroom to promote this interest during the school day as well, because the classroom-learning context also impacts a child's learning ecology. This provides a strong case for involving more kids, especially girls in out-of-school STEM opportunities. Schools are not alone in the obligation to maintain student interest in the STEM pipeline, as this is clearly a national issue.

Implications for State and National Education Policy in STEM

Though scholars have justly researched the issue of gender parity in the STEM fields for several years, not until recently has it surfaced as a national hot-button issue politically or in the mainstream media. Needless to say, local, state and national policymakers have vested interest in addressing the issue of gender parity in the STEM fields.

At the state level, the Next Generation Science Standards provide a framework to help produce more informed citizens and help American students pursue employment opportunities in science-related fields (Next Generation Science Standards, 2014) by providing an engaging curriculum in the context of the classroom. However, if state (and national) policymakers are serious about addressing the issue of gender equity in STEM fields, then it is important for them to understand that learning occurs across multiple contexts and extends beyond classroom walls. This study shows that learning science in an out-of-school context can help girls maintain an interest in pursuing a STEM career and also can impact interest in math classes in school.

Learning experiences outside the classroom, such as the after-school STEM programs analyzed in this study, are likely to help retain girls who are already on the STEM pipeline in middle school. Involving girls already interested in STEM in high quality out-of-school STEM programs appears to combat attrition at the middle level and even increases interest for those participating in multiple terms of engagement. This research provides a strong case for state and national policymakers to consider out-of-school time, when considering how to address the issue of gender parity in STEM fields.

Recommendations for Further Research

This findings and implications of this study revealed that there was still much work to be done in the area of gender parity in the STEM fields. The targeted population of this study was solely on girls in middle school; however, more work needs to be done in understanding the engagement of how out-of-school STEM learning experiences impact the confidence and interest of elementary school girls, because it is shown that girls in middle school and high school tend to have already shaped their interest or non-interest in science and related fields of study. Additionally, it is necessary to better understand the impact of such programs through qualitative studies, particularly through observations of participation during the elementary years, in hopes that the implications would lead to improving the experience of the participant in such programs.

This study explored the impact of the number of terms of engagement of an after-school STEM program on the confidence and interest of middle school girls utilizing a survey methodology. In order to better explain the impact of these programs, narrative studies on girls involved in these programs could prove significant. Of course, this study focused broadly on girls involved in after-school STEM programs. However, further research is needed to explore the differences of confidence in minority and non-minority girls. Studies focusing on minority girls are crucial to address the gender gap in employment.

Though the motivation of the girls enrolled in one or multiple terms of the after-school STEM programs was remarkable, they undoubtedly had incredible support from the adults in their lives at home. The impact of family was not taken into account in this particular study. Much research, including the works previously mentioned by Barron (2003) cast a child's family as an inordinate supporting role in their learning ecology. Further research is also needed to focus on the effects of familial influence on interest and confidence of kids who participate in out-of-school STEM learning opportunities.

Concluding Remarks

The problem approached in this study remains a very intimate topic for leaders, educators and researchers. The issue of parity in the STEM fields surely will face future generations of leaders, educators, and researchers. This study showed that multiple terms of out-of-school and informal STEM opportunities could impact the interest of young women interested pursuing a STEM career when they are in middle school. They can also impact the interest girls have in their math classes, which could lead to greater academic gains. Out-of-school STEM programs also appear to be effective vehicles to maintain the interest of girls in middle school.

The practical problem of getting girls more involved in STEM in college and beyond requires sparking an interest early on in the educational process in order to maintain the engagement of interested girls throughout their learning pipeline. The dedication of families, teachers, and mentors is necessary to provide resources for successful engagement of out-of-school STEM opportunities. Out-of-school experiences are a critical component of a child's learning ecology. Leaders need to invest informal science through out-of-school activities. Educators must capitalize on the time spent outside of the classroom through before- and after-school programs. Most importantly, parents and guardians need to recognize the curiosity that children have on how things work in the world and nurture their interests by affording them with enriching experiences to explore the world outside of the classroom. All children can be scientists and engineers.

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APPENDIX A

SURVEY INSTRUMENT

Your responses will remain CONFIDENTIAL.

What grade are you currently in? (Closed Selection)

What is your Gender? (Closed Selection)

What after-school STEM program did you participate in? (Closed Selection)

How many after-school STEM programs did you participate in?

For each of the following items below, select the ONE that best describes how you feel.

1- Strongly disagree (SD)

2- Disagree

3- Neutral

4- Agree

5- Strongly agree

Q1: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my science classes.

Q2: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my math classes.

Q3: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my science classes.

Q4: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my math classes.

Q5: After participating in the after-school STEM program at my school, I DO NOT feel confident that I can do well in my science classes.

Q6: After participating in the after-school STEM program at my school, I do not feel confident that I can do well in my math classes.

Q7: After participating in the after-school STEM program at my school, I wanted to have a career in mathematics.

Q8: After participating in the after-school STEM program at my school, I wanted to have a career in engineering.

Q9: After participating in the after-school STEM program at my school, I wanted to have a career in science.

Q10: After participating in the after-school STEM program at my school, I wanted to have a career in technology.

Q11: The after-school STEM program I participated in made me more interested in my science classes.

Q12: The after-school STEM program I participated in made me more interested in my math classes.

Q13: I am currently enrolled in (Middle School or High School)

Q14: Middle School Students: The after-school STEM program I participated in motivates me to take advanced science and math classes when I get to high school.

Q15: High School Students: The after-school STEM program I participated in motivated me to take advanced science and math classes in high school.

Q16: Boys are more likely to have a career as a scientist than girls.

Q17: Boys are more likely to have a career as an engineer than girls

Q18: Boys are more likely to have a career in technology than girls

Q19: Boys are more likely to have a career in mathematics than girls.

For each of the following items below, select the ONE that best describes how you feel.

1- Very Unlikely

2- Unlikely

3- I am undecided

4- Likely

5- Very Likely

Q20: In order to become a scientist or engineer, at least four years of college is necessary. After participating in the after-school STEM programs at my school, how likely are you to complete such advanced work?

For each of the following items below, select the ONE that best describes how you feel.

1- I am the poorest

2- I am below average

3- I am average

4- I am above average

5- I am the best

Q21: After participating in the after-school STEM program at my school, how do you rate yourself in on your abilities in science compared with your close friends?

Q22: After participating in the after-school STEM program at my school, how do you rate yourself on your abilities in math compared with your close friends?

Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.

Q24: Comparing yourself to your close friends how would you rate yourself in having the mathematical skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.

APPENDIX B

LETTER TO PARTICIPANTS

Dear Respondent,

I am a doctoral candidate under the direction of Professor Dee Spencer in the Mary Lou Fulton Teachers College at Arizona State University. I am conducting a research study to investigate the effects of afterschool STEM programs on middle school students' interest and confidence towards the subjects. STEM refers to the topics including science, technology, engineering and mathematics.

I am inviting your participation, which will involve answering a questionnaire that will take approximately 15 to 30 minutes of your time. You have the right not to answer any question, and to stop the questionnaire at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty, for example, it will not affect your grades or your ability to participate in any programs or activities. Although there is no benefit to you, there are possible benefits of your participation in this questionnaire, such as designing better after-school programs geared towards science, technology, engineering and mathematics. There are no foreseeable risks or discomforts to your participation.

Your responses and your identity will be anonymous. The results of this study will be collected with others and may be used in reports, presentations, or publications; however your name or identifying characteristics will not be known/used.

If you have any questions concerning the research study, please contact me at gcupp@asu.edu or (XXX) XXX-XXXX

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the

Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 9656788.

Click "Next" at the bottom of this page to continue to the survey.

Sincerely,

Garth M. Cupp

Doctoral Candidate

Mary Lou Fulton Teachers College

Arizona State University

APPENDIX C

APPROVAL FROM THE OFFICE OF CURRICULUM AND

LEARNING SERVICES FROM THE DESERT WILLOW SCHOOL DISTRICT

Date: April 12, 2013

To: Garth Cupp

Cc: IRB file

From: Desert Willow School District Institutional Review

RE: Acceptance of research project/proposal

Dear Mr. Cupp,

This letter is notification that your research proposal for conducting research in the area of after-school STEM programs impact on student achievement.

You may conduct your research in the Desert Willow School District as outlined in your proposal.

Please note that the Principal Investigator is responsible for 1) complying with human subjects research regulations, 2) retaining signed consents by all subjects (if applicable), 3) notifying the Desert Willow School District IRB of any and all modifications (amendments) to the protocol and consent form and submitting them to the IRB for approval before implementation and 4) supplying a final report to the district.

Sincerely,

Lorah J. Neville

Executive Director for Curriculum and Learning Services
IRB Representative

APPENDIX D

IRB LETTER

Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Dee Spencer ED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	04/24/2013
Committee Action:	**Exemption Granted**
IRB Action Date:	04/24/2013
IRB Protocol #:	1304009131
Study Title:	Effects of After School Stem Progression

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX E

DATA SUMMARY TABLE AND INDEPENDENT SAMPLES t TESTS (FEMALES SINGLE PROGRAM VERSUS MULTIPLE PROGRAMS) FOR GIRLS PARTICIPATING IN ONE AND MORE THAN ONE AFTER-SCHOOL STEM PROGRAM

Survey Item	Single Term			Mult. Term			t-value	df	Sig.	Effect Size
	Mean	S.D.	N	Mean	S.D.	N				
Q1: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my science classes.	4	0.767	35	4.13	0.869	23	-0.601	56	0.55	
Q2: After participating in the after-school STEM program at my school, I am confident that I can earn A's in my math classes.	3.6	0.775	35	3.61	0.891	23	-0.039	56	0.969	
Q3: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my science classes.	4.11	0.9	35	4.13	0.757	23	-0.071	56	0.944	
Q4: After participating in the after-school STEM program at my school, I am confident that I will do better than other students in my math classes.	3.54	0.98	35	3.52	1.08	23	0.077	56	.939	
Q5: After participating in the after-school STEM program at my school, I DO NOT feel confident that I can do well in my science classes	1.6	0.881	35	1.35	0.573	23	1.21	56	0.23	
Q6: After participating in the after-school STEM program at my school, I do not feel confident that I can do well in my math classes.	1.67	0.692	33	1.67	1.17	23	0	55	1	
Q7: After participating in the after-school STEM program at my school, I wanted to have a career in mathematics.	2.69	0.932	35	3.09	1.08	23	-1.5	56	0.138	0.40
Q8: After participating in the after-school STEM program at my school, I wanted to have a career in engineering.	3.06	1.33	35	4.22	0.902	23	-3.68	57	0.001**	0.97
Q9: After participating in the after-school STEM program at my school, I wanted to have a career in science.	3.49	1.04	35	4.29	0.55	24	-3.865	54.10	0.001**	1.05
Q10: After participating in the after-school STEM program at my school, I wanted to have a career in technology.	2.97	0.985	35	3.52	0.665	23	-2.35	56	0.022*	0.63
Q11: The after-school STEM program I participated in made me more interested in my science classes.	4	0.767	35	4.04	0.825	23	-0.205	56	0.838	
Q12: The after-school STEM program I participated in made me more interested in my math classes.	2.69	0.9	35	3.35	0.982	23	-2.64	56	0.011*	0.71
Q15: High School Students: The after-school STEM program I participated in motivated me to take advanced science and math classes in high school.	3.75	0.463	8	4	0	2	-0.73	8	0.486	
Q16: Boys are more likely to have a career as a scientist than girls.	2.43	1.313	35	2.35	0.982	23	0.252	56	0.802	
Q17: Boys are more likely to have a career as an engineer than girls	2.71	1.384	35	2.48	1.04	23	0.698	56	0.488	
Q18: Boys are more likely to have a career in technology than girls	2.63	1.395	35	2.48	1.04	23	0.442	56	0.66	
Q19: Boys are more likely to have a career in mathematics than girls.	2.2	1.106	35	2.57	1.12	23	-1.22	56	0.226	
Q20: In order to become a scientist or engineer, at least four years of college is necessary. After participating in the after-school STEM programs at my school, how likely are you to complete such advanced work?	4.29	0.667	35	4.58	0.717	23	-1.63	57	0.108	0.43
Q21: After participating in the after-school STEM program at my school, how do you rate yourself in on your abilities in science compared with your close friends?	4.17	0.514	35	4.04	0.624	23	0.873	57	0.386	
Q22: After participating in the after-school STEM program at my school, how do you rate yourself on your abilities in math compared with your close friends?	3.8	0.719	35	4	1	23	-0.886	56	0.379	
Q23: Comparing yourself to your close friends how would you rate yourself in having the science skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.	3.89	0.471	35	3.96	0.878	23	-0.399	56	0.692	
Q24: Comparing yourself to your close friends how would you rate yourself in having the mathematical skills necessary to earn a college degree in science, technology, engineering or math because of your participation in the after-school STEM program at your school.	3.74	0.78	35	3.8	0.834	20	-0.255	53	0.8	
Note 1: Effect sizes, .20 small, .50 medium, .80 large	* p<.05									
	**p<.01									