California State University,

Fullerton

MIDDLE SCHOOL GIRLS: PERCEPTIONS AND EXPERIENCES WITH ROBOTICS

A DISSERTATION

Submitted in partial fulfillment of the requirements

For the degree of

DOCTOR OF EDUCATION

In

EDUCATIONAL LEADERSHIP

Pre-K-12 Leadership

by

Tricia E. Hyun

Dissertation Committee:

Professor Karen Ivers, Chair
Professor Ron Oliver, College of Education
Expert Member Robert Pletka, Fullerton School District

2014

The dissertation of Tricia Eagin Hyun
is approved and is acceptable in quality and
form for publication on microfilm and in digital formats:

Approved By:

Expert Practitioner ______________________

Professor ______________________

Committee Chair ______________________

California State University, Fullerton
2014

ABSTRACT

The purpose of this qualitative case study was to investigate the impact a robotics curriculum might have on the experiences and perceptions of middle school girls in two California classrooms. The research found that middle school girls in two different California classrooms felt that their experiences with robotics were personalized experiences that were positive and rewarding. Additionally, the girls felt that robotics was a curriculum that they could relate to real-life, and it was a curriculum that was relevant to their lives. The research found that girls had perceptions about STEM fields that remained sex-biased, and they perceived that certain occupations were more geared toward woman than men and vice versa. Both teachers provided learning environments that were free from sexist constructs.

TABLE OF CONTENTS

LIST OF TABLES

To Legolas

Our First Robot

ACKNOWLEDGMENTS

I would like to recognize several individuals whose unconditional support contributed to the completion of my dissertation.

To my family, Robert, Michelle, and Bryan, the first to offer the time and the last to ask for the time—the countless hours of love you gave completed me.

To my mom and dad, Keith and Susan, who exceeded all expectations all while exploring the world.

To my dearest running partner and friend, Cindy Young, who gave the miles. Thank you for creating "Team 4AM"—all that you are made the last months go so much faster.

To my mentors, Sherry Dustin and Eric Mizutani, who gave unconditional support, care, and time.

To my experts, Dr. Cox, Dr. Oliver, Dr. Ivers, and Dr. Pletka, who modeled excellence and extraordinaire—bringing out the best in me.

To my colleagues Mike Bledsoe, who shared our students and took care of our students, and Jason Chong, who believed in the research and helped make it a reality.

To my teammates, Kim Barr and Phil Ling, thank you for being the builders and creators, and then, allowing me to tag along.

To my cohort, Azu, Kathy, Kelly, and Alicia, who became the family away from the family—you inspire me!

CHAPTER 1

INTRODUCTION

This chapter provides an introduction to and overview of the dissertation. The chapter begins with the background of the problem, which is divided into three sections: (1) the history of science, technology, engineering, and mathematics (STEM) and its current impact at the local educational level; (2) the data that indicate how our nation struggles in STEM and, more specifically, how our country faces an underrepresentation of females in STEM-related fields; and (3) robotics as one viable curriculum that educators are using to keep girls interested in STEM-related fields. Following the background of the problem are the problem statement, purpose of the research, significance of the study, research questions, and the scope of the study, including assumptions, delimitations and limitations, and definition of terms. The chapter concludes with an overview of the dissertation.

Background of the Problem

In 1994, the U.S. federal government passed Goals 2000, which provided a framework of standards that would support our nation's efforts to be first in the world in mathematics and science performance. At that time, the National Science Foundation had in progress an initiative that they were calling "SMET" (science, mathematics, engineering, and technology). The researchers quickly changed "SMET" to "STEM" when proponents wanted an acronym that would provide a more harmonious and decorative impression (Sanders, 2009). Fifteen years later, in 2009, President Obama confirmed the nation's focus on STEM with his initiative called *Educate to Innovate*, which launched a continued focus on STEM knowledge and skills locally and nationally.

Although a nationally agreed upon, concrete definition of STEM has remained elusive over the last two decades, policymakers and educators both nationally and locally have noticed the impact and importance of STEM education. As a result, the nation's researchers and policymakers have started emphasizing the value of a highly skilled and educated STEM workforce to the future economic leadership, competitiveness, and success of the United States (Carnevale, Smith, & Melton, n.d.; U.S. Department of Education, NCES, 2011). Meanwhile, a growing consensus of opinion among supporters led to their linking the country's potential for economic competitiveness with students' skills in STEM subjects (International Test and Evaluation Association, 2009; National Research Council, 1996). When the US Bureau of Labor Statistics (2006) predicted an increasing availability in the number of STEM-related jobs between 2010 and 2020, a stronger connection between the school system's focus on STEM and the nation's economic competitiveness surfaced. Value-laden presuppositions about the purpose of an education focused on preparing a knowledgeable workforce for a stronger economy ensued.

At the local level, states wanted to support educators with online STEM resources. California's Department of Education posted a comprehensive collection of STEM-related resources on their website's Professional Development page. The page broadly defined STEM:

> A sequence of courses or program of study that prepares students . . . for successful employment, post-secondary education, or both that require different and more technically sophisticated skills including the application of mathematics and science skills and concepts, and to be competent, capable citizens in our technology-dependent, democratic society (California Department of Education, 2013, "STEM Education," para. 1).

The website comprehensively bulleted the responsibilities that elementary, middle, and high schools had to uphold in preparing students for the STEM workforce (para. 3). For example, elementary schools needed to provide children with an awareness of STEM fields and occupations. Middle schools were responsible for beginning a student's exploration of STEM-related careers, and high schools needed to prepare students for successful post-secondary employment, education, or both.

Despite the overwhelming focus that policymakers and educators placed on STEM, compelling research continued to show that U.S. students struggled in science performance as compared with students of other countries. The National Center for Educational Statistics (NCES) summarized international results in a report, indicating that, by the eighth grade, six countries had higher percentages of students performing at or above the advanced science benchmark, and these same six countries had higher overall averages than the United States (U.S.

Department of Education, NCES, 2009c). But lagging international statistics were not the nation's only concern.

A range of research showed that girls struggled in STEM subjects more than did boys at multiple levels of their education, and the shortage of girls entering STEM-related fields was indisputable (Blickenstaff, 2005; Leaper, Farkas, & Brown, 2012; Milgram, 2011; Pettitt, 1995; President's Council of Advisors on Science and Technology, 2010; Robelen, 2011; U.S. Department of Education, NCES, 1997a; Waters, 2011; Zeldin, Britner, & Pajares, 2008). According to the National Research Council (2007), scores from the National Assessment of Educational Progress showed female students consistently scoring lower than male students in both mathematics and science at three grade levels: Grade 4, Grade 8, and Grade 12. According to The College Board's Program Summary Report (2011), 81% of the high school students who took the AP Computer Science test were male while only 19% were female, and 60% of students who took the AP Calculus BC exam were male, while only 40% were female. At the college level, only 15% of bachelor degrees awarded in engineering went to females while males received 85% of the degrees in 1990 (Engineering Workforce Commission, 2011). Two decades later, in 2010, the number changed by only 3%, with females earning 18% of bachelor degrees in engineering and males receiving 82% (National Science Foundation, 2011). In 2010, a University of California, Los Angeles, study showed that only 38.4% of freshman college students intended a science and engineering major, and from this percentage, only 33.3% stated they were female while 44.1% stated they were male (Higher Education Research Institute, 2009; National Science Foundation, 2007).

Several researchers associated the staggering STEM research results regarding female participation found at the college and graduate levels to perceptions and self-efficacy beliefs females create in elementary, middle, and high school (Blickenstaff, 2005; Farland-Smith, 2009; Pettitt, 1995). Research articles and journals referred to a "leaky pipeline," a metaphor describing obstacles females could have faced between grades K-12. Margolis and Fisher (2002) confirmed that adolescent girls develop negative perceptions about STEM fields as they grow into their identities; by eighth grade, girls who once thought they were good at math and science no longer felt that that was the case. Several researchers started to investigate the leaky pipeline further.

One researcher found that girls between Grades 7 and 12 formed narrow and limiting perceptions about STEM fields causing them not to identify with science professions as they moved into college and graduate school (Farland-Smith, 2009). Farland-Smith found that personalized images and cultural impressions influenced girls' perceptions of scientists. Another researcher found that girls and women who knew someone good at mathematics were more likely to form positive ideas about STEM fields (Bryant, 2011). Consequently, over the years, several initiatives focused on adolescent girls' access to female role models (White House, n.d).

Some researchers started connecting girls' middle school years, their self-efficacy beliefs, and their sex-typed perceptions about STEM fields. For example, Zeldin et al. (2008) found that self-beliefs, or self-efficacy beliefs, greatly influence a girl's decision not to pursue a science-related field, especially during adolescence. Additionally, Pettitt, Patrick, and Sternitzke (1995) discovered that "although girls and boys believe society accepts multiple career options for women and men, their own career aspirations remain fairly sex-typed" (p. 2). Their study showed that girls considered themselves capable of becoming doctors or veterinarians, but they did not consider themselves capable of science-related jobs "even though both required extensive skills and training in math and science" (p. 3). In other words, girls did not associate these occupations with science. The study concluded that girls needed more information about science-related jobs and what was required to pursue specific science-related careers. Their perceptions about certain science fields over others differed, causing them not to choose certain professions. Farland-Smith (2009) noted that middle school girls are especially vulnerable to sex-typed perceptions because they are in the midst of forming their identities.

Researchers also investigated middle school girls' learning environments. Sadker and Sadker (1994) found that, even though the girls were seated in the same classrooms, reading the same textbooks as boys, girls and boys experienced very different educational environments. In several classrooms, the researchers heard remarks made by teachers that explicitly stated gender biases. Sadker and Sadker noted that a "stubborn persistence of the hidden sexist lessons" indeed existed (p. 1). In other words, with a sexist delivery of the lesson, the curriculum was not the only lesson that teachers delivered—they also delivered a lesson on sexism. Potter and Rosser (1992) found that sexist language and images existed in middle school textbooks with a minimal amount of female achievements discussed, and they felt that this could add to the culture of sexism. Whether it was the classroom or the curriculum that was contributing to the inequities, a need for change was evident.

One change that some schools made to motivate adolescent girls to consider STEM-related courses was an increased focus on hands-on activities that required group work. Recently, NCES asked teachers about how frequently science students did hands-on activities or investigations in science class (U.S. Department of Education, 2011. Students of the teachers who reported that their students did hands-on projects every day or almost every day scored higher than students whose teachers did hands-on projects in class less frequently. Additionally, if the students collaboratively worked on science projects weekly or daily in the classroom, the average score for those students ranged higher than those of students who worked together only monthly or never. One year later, this same report suggested that "female students . . . scored higher than males on the hands-on tasks [with] no gender gap" on new computer-based assessments. Female students thrived when programs stressed cooperative, hands-on experiences (Thom, 2001).

With the U.S. Department of Education encouraging alternative approaches, some researchers have investigated alternative curricula (Barker & Ansorge, 2007; Chambers & Carbonaro, 2003; Mataric, 2004; Mauch, 2001; Palumbo & Palumbo, 1993; Robinson, 2005; Williams, Ma, Prejean, Ford, & Lai, 2007). Several of these researchers studied robotics as an alternative curriculum that used computer-programmable robots that participants could design, construct, and operate. One type of robotics curricula, the LEGO robotics NXT curriculum, functioned as a "mindtool" (Jonassen, Peck, & Wilson, 1999) allowing participants to take active roles (researching, programming, and building) in the learning process. Mauch found that the LEGO NXT robots "show[ed] promise in helping students not only with direct, hands-on problem solving, but with written problem solving as well" (p. 211). Mataric called for the consideration of robotics as an alternative curriculum at all educational levels.

Few studies have qualitatively evaluated the impact that a robotics curriculum could have on middle school girls' perceptions about STEM-related fields. Additionally, few studies have identified whether or not alternative approaches could open doors and pave avenues for middle school girls and their perceptions about STEM related fields.

Problem Statement

The problem this study will address is whether or not robotics is a viable curriculum for interesting middle school females in STEM-related fields. Research shows that adolescent girls can lose interest in STEM-related fields as early as middle school (Eccles et al., 1993; Farland-Smith, 2009, Potter & Rosser, 1992). Additionally, research shows that classroom environments, including sexism in the classroom, can impact the perceptions that girls may form about STEM-related fields (Sadker & Sadker, 1994). To address these problems, researchers have looked at schools that are trying to use cooperative, collaborative, and constructivist learning approaches like robotics to keep girls interested in STEM fields (Stieler et al, 2006; Sullivan, 2013; Ward, Miller, & Sienkiewicz, 2012). With a focus on these alternative approaches, educators are beginning to consider robotics as a viable curriculum that may support girls and their learning styles and increase their willingness to stay in STEM fields (Anderson, 2005; Philbin, Meier, Huffman, & Boverie, 1995).

As researchers examined the potential that robotics had as an alternative curriculum to keep girls interested in STEM-related fields, some of the researchers delineated the benefits a robotics curriculum could have on girls in comparison with boys (Barker & Ansorge, 2007; Chambers & Carbonaro, 2003; Mataric, 2004; Mauch, 2001; Palumbo & Palumbo, 1993; Robinson, 2005; Williams et al., 2007). However, few of these researchers inquired about the experiences and perceptions that female students had during and after participation in a robotics program. Few of the researchers looked at robotics as a potential gateway to help girls stay interested in STEM-related fields.

Purpose of the Research

The purpose of this qualitative case study was to investigate the impact a robotics curriculum might have on the experiences and perceptions of middle school girls in two California classrooms. Further, it aimed to determine if participation in a STEM-based, robotics curriculum promoted a classroom free of sexism where female participants could thrive. Finally, the research might inform educators about robotics as an alternative STEM curriculum that encourages female participation. By conducting the research in STEM-based robotics classrooms at local middle schools, the researcher investigated peer interactions, teacher and student interactions, and student and robot interactions closely. Through observations and interviews with middle school girls, the researcher sought to understand unintentional barriers that could surface and parts of the curriculum that could promote a safer, more equitable classroom. The researcher hopes that the research will help educators consider conditions that can promote gender equity and access.

Research Questions

This research study addressed following questions:

1. How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?
2. What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?
3. How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?
4. How do two teachers describe the performance of middle school girls participating in their robotics classroom?

Significance of the Study

A qualitative case study of the robotics curriculum and how it impacts the experiences and perceptions of middle school girls can be very informative. The study was designed to add to local educational leaders' understandings of how a robotics curriculum might impact girls' motivation and sense of self-efficacy. The study also investigated unintentional biases that may sometimes surface in STEM classrooms. Through the voices of middle school girls and teachers, the researcher hoped to inform educational leaders on how to create an equitable classroom with quality curriculum that is accessible. Finally, the research could provide curriculum experts in STEM fields with pertinent information about how adolescent girls study and learn best in STEM classrooms.

A call for STEM-based classrooms free of sexism has surfaced. The National Science Teachers Association (2013) argues that classroom teachers need to promote gender equality. The National Council of Teachers of Mathematics compiled several articles to support research and development in teaching STEM. This study may help to inform educational leaders on the critical components necessary to ensure that female students have an academic STEM environment that is free of biases, obstacles, and barriers.

This research can also support educational leaders who are interested in an innovative curriculum like robotics. Robotics expands beyond the traditional technological tools common in today's classrooms. Robotics can afford students a newer, more innovative approach to STEM fields, and it can offer teachers tools that support 21st century demands.

Scope of the Study

The scope of the study encompassed middle school girls in two separate robotics classrooms at two Southern California middle schools. The researcher observed the robotics classrooms and conducted interviews with 11 of the girls in the classrooms and two robotics teachers.

Assumptions of the Study

The study assumed that the participants of the robotics classroom or the robotics teachers would not change their behaviors or answers to questions based on the role of the researcher. Ideally, the participants and the teachers would act candidly in the classroom and answer all interview questions truthfully. Especially in a classroom setting, students or teachers can succumb to the pressures of an outsider. Whether the outsider is a child or an adult, the classroom dynamics can change. Sometimes the class will change positively with quieter, more respectful behaviors; however, in some cases the opposite can happen. An outsider can have the effect of allowing students to push limits.

Another assumption of the study included the initial purpose of the class and how the school selected the participants and the teachers. If the initial purpose of the robotics class was to encourage adolescent girls to pursue STEM-related fields, then the study would be limited to a set number of girls who volunteered to be a part of the class. This would have yielded different data than that derived from female students who were selected randomly. Related to this assumption is the method that the school took to select the instructors for the course. If the instructors teaching the course are experts in STEM fields and proponents of females entering STEM-related fields, then their teaching styles, lessons, and interactions might reflect sensitivities to the initiatives encouraging female participation in STEM-related fields.

Study Delimitations

The researcher delimited the study to middle school girls in a robotics classroom setting. Although the researcher observed the interactions between boys and girls in the robotics classroom setting, male students were not interviewed. The review of the literature made it clear that females make choices, decisions, and judgments about STEM fields based on experiences and perceptions that they have. The purpose of the study was to hear the voices of the female participants, to see what their perceptions about STEM field were, and to see if a robotics classrooms setting could support their new or continued interests in STEM fields.

Hence, the researcher delimited the study to the adolescent girls who were participating in the robotics classroom. The researcher needed to hear the voices of girls to determine experiences and perceptions of the robotics classroom. The robotics classroom, as a newer, more up-and-coming curriculum in the Southern California area, became the STEM-based venue. Observations and interviews of middle school girls and teachers in the STEM-based classrooms supported the purpose of the research and the research questions.

Study Limitations

A potential limitation to the study was the ratio between the number of girls and the number of boys in the classroom. If boys outnumbered the girls in the classroom, then observations may have shown more boys participating and engaging in discussions than girls. If girls outnumbered the boys, the same distortion to the data could have occurred.

Another limitation to the study was the time frame. The researcher needed to observe the classroom when hands-on, direct manipulation environments (DME) were on the daily agenda. If the researcher observed on a day when the instructor was lecturing, the observation data may not have included enough information regarding participation and engagement.

Definitions of Terms

Direct manipulation environment (DME). DME is an environment where students are able to control and build solutions to prescribed outcomes (Slangen, Van Keulen, & Gravemeijer, 2011).

Gender bias. Unequal treatment in the classroom based on the sex of the student is referred to as gender bias.

Perceptions. Perceptions are intuitive understandings or insights that students may develop based on new ideas.

Prescribed outcomes. Prescribed outcomes are specific missions that robots must accomplish based upon the programming that its owner may create.

Robotics. An alternative STEM curriculum, robotics allow students to control and build solutions to prescribed problems using a handheld robot and computer programs (Barker & Ansorge, 2007; Chambers & Carbonaro, 2003; Mataric, 2004; Mauch, 2001; Palumbo & Palumbo,1993; Robinson, 2005; Slangen et al., 2011; Williams et al., 2007).

STEM. STEM is an acronym for science, technology, engineering, and mathematics. Although a nationally agreed upon definition does not exist, the California Department of Education is defining STEM as "a sequence of courses or program of study that prepares students . . . for successful employment, post-secondary education, or both that require different and more technically sophisticated skills, including the application of mathematics and science skills and concepts, . . . to be competent, capable citizens in our technology-dependent, democratic society" (California Department of Education, 2013).

STEM classrooms. In STEM classrooms, rigorous academic concepts are coupled with real-world, problem-based and performance-based lessons (California Department of Education, 2013).

Organization of the Dissertation

Chapter 1 introduced the background of the problem; problem statement; purpose of the study; significance of the study; research questions; scope of the study, including assumptions, delimitations, and limitations; definitions of terms; and an overview of the problem. Chapter 2 presents a critical review of the literature pertaining to the research questions. Chapter 3 contains the research design, including data collection and analysis methods. Chapter 4 lists the findings by research questions, and Chapter 5 concludes with discussions and recommendations based on the findings.

CHAPTER 2

REVIEW OF THE LITERATURE

The problem this study sought to address is the shortage of girls in science, technology, engineering, and mathematics (STEM) related fields, and the purpose of the study was to investigate the impact a robotics curriculum might have on the experiences and perceptions of middle school girls in two California classrooms. This chapter begins with a summary of the theoretical foundation: critical feminist theory. Next, the researcher provides the the conceptual framework that guided this study followed by a review of literature exploring the reasons for the shortage of girls in STEM-related fields as well as an alternative curriculum that schools have used to change girls' perceptions and experiences with STEM-related fields.

Theoretical Foundation

The research for this dissertation is grounded in the literature on critical feminist theory, which emphasizes the liberation of individuals, specifically females, from oppressive, political, and cultural conditions like sexism (Noddings, 2012). Some may say that sexist attitudes and conditions no longer plague our country; however, sexism, like racism, is pervasive. Females face domination by males at multiple levels.

One way to understand a critical feminist's approach is to look at the critical theorists in education who once tried to narrow their beliefs into a "correspondence theory" where "the structures of schooling and classroom discourse correspond[ed] directly to the class structures of society and that this correspondence explain[ed] how the school 'reproduce[ed]' the society's class structure" (Noddings, 2012, p. 74). Just as a particular style of discourse within the walls of a classroom might reproduce the class structures of a society, sexist discourse within the classrooms, sexist language within the textbooks, and sexist ideologies among peer groups correspond with gender structures, frameworks, and systems in our nation. As a result, there is a shortage of girls and women in STEM-related fields.

Review of the Scholarly Empirical Literature

A number of articles in the area of the shortage of girls in STEM-related fields identified obstacles and barriers that girls face during their adolescent years. Several articles point to middle school as a critical juncture where barriers and obstacles start to surface more pointedly. The literature review will also look at questions posed about the traditional classroom, where sexism could surface through teachers or curriculum. Finally, a number of articles looked to robotics as alternative curriculum that could potentially salvage girls' perceptions of and experiences with the STEM-related fields.

Conceptual Framework

The conceptual framework for this study is grounded in three bodies of literature. Two bodies of the literature explain reasons for the gender gap: the sexist classroom and self-efficacy struggles that can lead to negative perceptions middle school girls have about STEM fields. The review of literature concludes with a body of literature on robotics, an alternative curriculum that educational leaders have experimented with, seeking to sustain, support and potentially salvage girls' perceptions about STEM-related fields.

The Sexist Classroom

Researchers suggest that the problem begins in the unchanged classroom (Bandura, 1986, 1994; American Association of University Women, 1995, 2000; Blickenstaff, 2005; Leaper et al., 2012; Milgram, 2010; Pettitt, 1995; Robelen, 2011; Waters, 2011; Zeldin et al., 2008). As the schools usher female students through the pipeline from elementary to high school and from undergraduate to graduate degrees, they are finding that females are not choosing STEM-related fields.

Sadker and Sadker's (1986, 1992, 1994) comprehensive studies found that sex biases and inherently sexist lessons existed at multiple levels in classrooms. Their pioneering research between 1980 and 1984 uncovered the "pervasiveness of sex bias" in classrooms across the country at multiple levels—from elementary school to higher education (p. 512). Sadker and Sadker's study involved three years of observations that ranged from inner city classrooms to affluent suburban classrooms; additionally, they investigated classrooms that were racially integrated and racially segregated. They analyzed their findings for over a year.

Sadker and Sadker (1994) found "shocking patterns of sexism in schools . . ." (p. x). A study that, at first, was supposed to look at sex bias in textbooks, ended up being a study that looked mainly at sex bias in the ways that teachers treated their students and students treated their peers. Male students received more attention than females, and teachers were oblivious to gender biases that they, themselves, may have been instigating. Even though girls were "sitting in the same classroom, reading the same textbook, listening to the same teacher, boys and girls [were] receive[ing] very different educations" (Sadker & Sadker, 1994, p. 1). The researchers called for educators to collaboratively transform educational institutions into places where equality and accessibility were inherent.

Alongside Sadker and Sadker's comprehensive studies, a plethora of other studies confirmed that female students frequently faced sexism in the classroom (Brown, 2002; Hall & Sandler, 1982; Potter & Rosser, 1992). Hall and Sandler discovered that female students experienced "chilly" climates in the classroom that were a direct result of inequities revealed in the classroom's environment (p. 1). The researchers concluded, "the myriad [of] small inequities that by themselves seemed unimportant, but taken together create[d] a chilling environment" for female students (p. 1). Simple, and often unintentional, behaviors from teachers, students, or peers struck female students in a way that was not warm and inviting.

Maras and Archer (1997) found that differences in educational practice for females and males persisted, and in school, educators talked to females in a way that was different from the way they talked to males. Another researcher confirmed Maras and Archer's research, further pinpointing that not only teachers but also administrators and counselors shortchanged female students when it came to fostering the potential for females to enter and stay in STEM-related fields.

Farland-Smith (2009) confirmed, "Parents, teachers and school administrators have unknowingly provided experiences for children that lead them away from, rather than toward, rich and rewarding experiences in science" (p. 416). In a mixed-methods study involving 28 female middle school students, five university scientists, and an experiment where students worked within a curriculum that focused on "side-by-side" interactions with scientists, Farland-Smith conducted surveys and questionnaires that had a pre- and posttest component. The researcher also used journals and drawings to make conclusions about middle school girls and their perceptions about science. Analyses included a range of perceptions that girls created about scientists, but more specifically, the research demonstrated that "middle school girls' perceptions about the *appearance, location*, and *activities of scientists* can be maintained or improved as a result of the 'Side-by-Side' experience" (p. 421). The significance of this study is that the classroom's curriculum impacted girls' perceptions of STEM-related careers.

Eccles et al. (1993) found that middle school students experience a regression as they transition to the middle school environment, and they also experience a decreased opportunity to participate in classroom decision-making. In junior high school, students attend six or seven periods that are approximately 40-55 minutes long. Unlike elementary school where one teacher takes charge of a child's educational school day, in junior high school, students deal with six or seven teachers daily. This shift in the number of teachers can lead to the abovementioned changes.

Eccles et al. (1993) also noted a "decrease in intrinsic motivation" experienced by middle school students (p. 99). Their research marked junior high school as a critical time in a student's life because classroom opportunities could afford them "higher level thinking skills . . . [and] complex academic tasks" (p. 99), but that was not necessarily what the researchers saw in the middle school classrooms. Observations in junior high schools showed that classrooms provided few opportunities for higher level creative and expressive skills, and "the most frequent activity involved copying answers from the board or textbook onto worksheets" (p. 94).

Often, sexism in a classroom is the direct result of a sexist curriculum and sexist textbooks in a classroom. Potter and Rosser (1992) discovered that sexist language and sexist images still existed in middle school textbooks, with a minimal amount of female achievements rendered. While analyzing five middle school life science textbooks, the researchers found subtle and unintentional forms of sexism within the textbooks. In addition, activities that would be beneficial to motivating females were missing.

Self-Efficacy Beliefs

The sexism found in the middle school curriculum is not the only factor within and among the middle schools that limits parity for female students. Literature suggests that middle school females struggle with self-efficacy and perceptions about the STEM fields, as well. In 1977, Bandura explained how strong self-efficacy beliefs preempted positive behavioral change. The article confirmed that one's psychological stance, or position, derived directly from one's ability to perform, or experience, a phenomenon at a mastery level. Bandura found that "the strength of people's convictions in their own effectiveness is likely to affect whether they will even try to cope with given situations" (p. 193). Additionally, self-efficacy not only "promote[d] behavioral accomplishments but also extinguish[ed] fear arousal" (p. 195). People could potentially extinguish feelings of potential failure as long as they had positive prior experiences that promoted success and accomplishment. Moreover, Bandura called for investigation into the "operative process involved in the relationships between efficacy expectations and action" (p. 212).

For decades, researchers attempted to explain gender gaps in math and science achievement using gender differences theories (Blickenstaff, 2005; Halpern et al., 2007; Hyde, 2005). Drawing quantitative conclusions, researchers expounded that males had a science and math-minded psychological ability that females did not have (Maccoby & Jacklin, 1974, as cited in Hyde, 2005). Quickly, mass media and popular culture started scrutinizing these gender differences theories with bestselling books about gendered planets, gendered professions, and other gendered reasons why females might not be as successful as males in science, technology, engineering, and math (STEM) fields and high-paying jobs.

When researchers failed to consider the implications for their gender differences theories and claims, Hyde (2005) admonished with an opposing approach: the gender similarities claim. She warned against the exaggerated gender differences claims because of the negative impact it could have on a female's opportunities and an adolescent girl's self-esteem. She pressed for a focus on gender similarities, especially since her research on gender differences actually resulted in stark support of a gender similarities hypothesis.

Although Hyde's gender similarities claim generated some support with female-empowering books like *Smart Girls* (1997) and *Her Story* (2013), the gender differences theories had already generated a plethora of overt and subtle biases that limited and obstructed females. Between Sadker and Sadker's seminal work on the sexist classrooms and Hyde's pioneering perspective on the unintentional consequences of the gender differences claims, evidence of gender disparities undoubtedly existed. Biases, obstacles, barriers, and stereotypes led females to develop lowered self-efficacy beliefs and negative perceptions about their potential, especially in STEM fields (Farland-Smith, 2009; National Academies of Science, 2005; Zeldin & Pajares, 2000).

Self-efficacy and females. Bandura (1977) defined self-efficacy beliefs as the "experience of mastery arising from effective performance" (p. 191). He discovered that positive mastery experiences, or activities that warranted accomplishment, proved a powerful indicator of behavioral change. Central to his construct was the idea that people socially constructed both positive and negative identities (i.e., science and math identity) based on a capability or incapability of producing or accomplishing the work.

Bandura (1977) found two other factors that enhanced self-efficacy beliefs: vicarious experiences and social or verbal persuasions. When people observed others performing tasks, they classified the individual's performance as successful or not successful. From these judgments, individuals felt that they were able to vicariously create their own personal models for capability and achievement. Additionally, when individuals experienced positive social and verbal persuasions from other individuals, they felt encouraged in the area in which they received the social or verbal persuasion.

Zeldin and Pajares (2000) found that females needed to construct positive self-efficacy beliefs about their abilities in STEM-related fields before selecting and continuing in their STEM careers. Evaluating the narratives of 15 women in mathematics, science, or technology careers, the researchers used case study methodology to explore rich descriptions that they narrated about their lives and their careers. The researchers discovered that the male-dominated academic domains of our society required females to have verbal persuasions and vicarious experiences that broke down stereotypical preconceptions. The researchers stressed that parents and teachers of the participants needed to encourage females "to persist and persevere in the face of academic obstacles" (p. 241).

Even though the female participants in Zeldin and Pajares' (2000) study frequently heard and recalled negative gender messages regarding their abilities, other social and verbal persuasions plus vicarious experiences that were positive helped them overcome the negative gender messages. Some female participants stated that they had to feel capable of producing the work (i.e. mastery experiences). Several women stated that "[people] engendered in me that attitude that I could do absolutely anything I ever want[ed] to do" (p. 229). These social persuasions, heard from parents, teachers, and friends, contributed to positive self-efficacy beliefs that contributed to continued growth in STEM-related fields. Another woman explained, "My dad . . . always encouraged me in math and science, and I thought I could do anything the boys could do, so it was never a problem" (p. 228). They also noted that the theme of others believing in them proved more important than their own personal self-efficacy beliefs. One female participant stated, "My father never expected his girls to be soft and female. We were raised to be tough" (p. 230). Moreover, even if the female participants experienced positive mastery experiences and vicarious experiences, the verbal and social experiences and expectations had quite an impact, too. This study confirmed that self-efficacy beliefs in girls and women contributed greatly to a female's future involvement in STEM fields.

Later, Zeldin et al. (2008) investigated the narratives of 10 Caucasian males in the United States through a qualitative case study. The 10 male participants, also from STEM-related fields, told stories about factors that influenced their academic and career choices. They described mastery experiences as the most influential source for their personal self-efficacy beliefs in regards to STEM-related fields. They created strong self-efficacy beliefs about STEM-related fields when they had the ability to experience achievement within a STEM related field. Unlike the women, "*others* believing in *them*" was a non-factor, and "it is not surprising that most men did not mention being affected by negative social messages . . .they simply did not seem to face obstacles related to social identity" (p. 1050). The implication was clear: males did not experience the same obstacles that females experienced in terms of verbal and social persuasions that impacted self-efficacy beliefs.

Self-efficacy beliefs in adolescents. Usher and Pajares (2009) wanted to fill a gap that they saw in the literature in regard to self-efficacy beliefs of middle school students in STEM fields. They noticed that several studies looked at college and high school students, but few studies analyzed middle school students. Using a focus group of middle school students, parents, teachers, and administrators, they developed a survey to administer to over 1,000 middle school students. They found that a correlation existed between middle school students who had mastery experiences and middle school students who had strong mathematics self-efficacy beliefs. Both researchers suggested the implications for middle school classrooms, suggesting that perceived mastery experiences could be a powerful source of students' mathematics self-efficacy. Unfortunately, their literature did not delineate self-efficacy factors between females and males.

However, Seaton (2007) did study self-efficacy for females. Seaton found that vicarious experiences had a large impact on adolescent female self-efficacy beliefs. She qualified a child's adolescent years as a critical time in self-efficacy development:

> During this period, adolescents develop the ability to think abstractly about their place in the world and evaluate their capacity to become efficacious young adults. Thus, adolescence represents

> a critical juncture in which one first begins to negotiate the intersection of one's own self, beliefs, values, worth, and potential in a particular society and culture. (p. 2)

Seaton studied 20 middle school, rural eighth-grade girls in an ethnographic study, and she found that the care for the self-efficacy of young, adolescent girls, did not necessarily involve academic needs, but emotional and relational needs were just as important in supporting their feelings of self-worth, healthy identity, and full potential.

In addition to her findings in regard to curriculum and the classroom, Farland-Smith (2009) found that females needed vicarious experiences to build self-efficacy beliefs in regard to STEM fields. She studied 28 female middle school students at a major midwestern university that was holding a summer camp for kids. The students worked side-by-side with five university scientists in an urban setting. The researcher found that middle school students developed perceptions about what scientists looked like, where they worked, and what they did. These perceptions impacted self-efficacy beliefs that the girls would develop about STEM fields.

Self-efficacy and negative perceptions. Several researchers have looked at adolescent girls' perceptions about STEM fields (Blickenstaff, 2005; Farland-Smith, 2009; Pettitt, 1995). One researcher, Pettitt, studied 162 boys and girls from a suburban Denver middle school. She found that girls sex-typed careers even though they felt that society accepted both men and women in several different fields. Especially when it came to science-related jobs, girls did not see themselves as having the necessary skills to succeed. They also worried about how to balance a career and family. The study solidifies research-based limitations that females face in regard to their science ability and how they relate to their decision to enter or not to enter a STEM-related field.

Recently, Farland-Smith (2009) argued that female students are still not realizing that they are forming perceptions about the physical sciences that are "narrow and limiting," not allowing them to identify with STEM fields (p. 415). Farland-Smith cited Carlone (2004) to explain "science identity," and how it manifests itself in two ways. First, when a female student is or is not able to competently perform relevant scientific practices, her science identity develops, or regresses. Second, if a female student gets recognized as a science-minded person by others based on her successful or unsuccessful science performance, her science identity develops or regresses. The study showed that any negative science identity that the middle school girls produced or perceived tended to steer them away from STEM-related fields. Farland-Smith (2009) found that when parents told their daughters that their intelligence could certainly expand with experience and learning, girls did do better on math tests and were more likely to say they wanted to continue to study math in the future.

Answering Sadker and Sadker's (1994) call for classroom transformations and responding to researcher's findings on self-efficacy beliefs in adolescent girls, leading institutions and organizations compiled lists of resources to improve equity and accessibility in the classroom (STEM Equity Pipeline, 2013; STEM Resources, 2013).

Robotics

Traditionally, teachers have put technology in the classroom so that the technology could "teach" students (Jonassen et al., 1999). As a result, in some classrooms, technology created situations where students became passive learners, robotically pressing keys, allowing the computer to take the more active role. Moreover, Jonassen et al. exhorted against the use of traditional technology because they feared that technology was removing meaningful control that the learners or the teachers needed to have during the learning process. Instead, these researchers argued for mindtools that could support the construction, or creation, of knowledge through active, cognitive learning processes.

One type of learning mindtool that several researchers have studied is robotics (Barker & Ansorge, 2007; Chambers & Carbonaro, 2003; Mataric, 2004; Mauch, 2001; Palumbo & Palumbo, 1993; Robinson, 2005; Williams et al., 2007). Barker and Ansorge straightforwardly defined robotics as "a toy . . . [that children] can build and program" that has "left assembly lines and research labs and arrived on the doorstep of education" (p. 229). Several researchers have found that, unlike traditional technological tools (i.e., desktop or laptop computers), robots provide students with active and engaging roles that required collaboration, critical and logical thinking processes, and problem-solving skills. Chambers and Carbonaro (2003) described robotics as allowing students "to creatively explore computer programming, mechanical design and construction, problem solving, collaboration, physics, motion, music—all within an active, enjoyable, and nonthreatening setting" (p. 209). Mataric (2004) argued that the growing field of robotics could drastically change engineering education and science education at multiple levels, from K-12 to graduate school.

McDonald and Howell (2012) used robotics in an early education classroom with students aged 5-7 years and found that an "extraordinary opportunity" existed for the use of robotics in classrooms (p. 649). Rogers and Portsmore (2004) used robotics in elementary school classrooms and discovered that robotics is an "effective platform" for teaching engineering in schools (p. 24). Nugent, Barker, Grandgenett, and Adamchuk (2010) examined the impact of robotics on middle school students and found that "short-term robotics interventions appear to be highly successful in impacting student science, technology, engineering, and mathematics (STEM) attitudes and getting students excited about robotics and geospatial technologies (and STEM in general)" (p. 404). Finally, Mataric (2004) taught introductory robotics at the undergraduate and graduate level and found that robotics was an excellent and compelling topic for students of all ages.

Robinson (2005) explained that the robotics curriculum is a very different tool from the traditional computers and textbooks that classrooms usually use. In contrast to traditional classrooms where students are seated in rows, textbooks open to a particular page with a teacher at center stage, today's classroom observer might notice how some science and math teachers are integrating hands-on activities that require group work. Additionally, some observers might notice innovative technological tools like iPads and document cameras. As noted in Chapter 1 of the proposal, NCES asked teachers about how frequently their science students did hands-on activities or investigations in science (U.S. Department of Education, NCES, 2011). Among the teachers who reported that their students take part in hands-on project every day or almost every day, students "scored higher on average than students whose teachers reported students did hands-on projects in class less frequently." Additionally, if the students worked on science projects collaboratively weekly or daily in the classroom, the average score for those students ranged higher than that of students who worked together only monthly or never.

Slangen (2010) explained how, unlike traditional curricula, robotics exists in a DME. In a DME, students can collaboratively design, creatively control, and imaginatively build solutions to prescribed outcomes. A prescribed outcome is a mission or task that robots must accomplish based upon a programmer's or builder's unique model; multiple models, or hardware and software builds, can exist. A number of different models can accomplish the one task. For example, an instructor might ask students to program a robot to place a ball in the hoop of a basket that is five feet away. The prescribed outcome is the placement of the ball into the hoop. The means through which the robot accomplishes this task is different based upon the ideas, thoughts, creativity, and builds of the student–the robot's engineer. One robot engineer might accomplish the task with a one-armed robot while another robot engineer might accomplish the task with a whole different contraption.

Robotics requires creativity and imagination (Jonassen, 1984; McDonald & Howell, 2012; Slangen et al., 2011). Unlike curriculum theorists, who traditionally believed in a most efficient means of transmitting fixed bodies of knowledge in formalized manners using textbooks and lectures (Pinar, 1978, as cited in Glatthorn, Boschee, Whitehead, & Boschee, 2012, p. 93), proponents of robotics view education as an existential experience that allows the learner to learn with the technology instead of from the technology (Jonassen et al., 1999). Nugent et al. (2010) explained how robotics has a "hands-on, creative, self-directed learning" approach (p. 404). Chambers and Carbonaro (2003) posited that students participating in robotics enjoyed the hands-on, activity-based, constructionist approach.

A hands-on, constructionist approach that is inherent in a robotics curriculum not only supports the student's engagement in multiple subjects but also builds confidence in students (Ontiveros & Alvarez, 2012). Unlike other technological mediums, robotics requires students to "gain a sense of power over [the] technology" through building and programming (p. 230). Papert (1980) found that "children could identify with the robots because they [were] concrete physical manifestations of the computer and the computer's programs" (as cited in Barker & Ansorge, 2007). Additionally, with robotics, students are involved with the creation of an object that becomes part of the creator's world (Martin, Mikhak, Resnick, Silverman, & Berg, 2000).

Slangen et al. (2011) summarized a robotics curriculum into four concepts: psychological perspectives, technological perspectives, function perspectives, and controlled-system perspectives. Psychologically, robots share humanistic attributes: they sense, they take up space, they move, and, among other attributes, they recognize their surroundings (upon programming). Technologically, robots can move and function with programming that gives them these abilities. Functionally, they can perform and complete tasks prescribed by the engineer who manipulates their next move. Finally, robots are "man-made devices able to interact autonomously with their surroundings based on a pre-defined program or by means of remote control" (p. 453). They are not in control, but the systems engineer who designates their next move, the controller, is in control.

Robinson (2005) found that the concepts found in robotics materials made physical science content more interesting to learn (p. 81). Using case studies with three science teachers, Robinson discovered that robotics promoted inquiry and made science more interesting to students. He concluded, "all students can benefit from a curriculum that makes connections and application to society" (p. 81). The robotics curriculum, unlike other science or technology curriculum, connected with students because of its application to society. Whether it was the automated tellers at the banks that functionally performed tasks or robotic vacuum cleaners with sensors, the students saw a connection to society. Unfortunately, Robinson's study did not delineate whether the participants were men or women.

Martin et al. (2000) conducted a robotics research case study at the Massachusetts Institute of Technology where he divided undergraduate college students into three sections: the first section focused on two undergraduate college students who built robots for two consecutive years in a robot design class, the second section involved a classroom full of undergraduate students who had to design a robot for a contest, the third section provided an analysis of the robotics curriculum he used. Martin concluded that hands-on experiences that students can have before entering college-level engineering courses can support their respect for projects that are grounded in reality. Again, however, the researcher did not delineate the participants' gender.

Chambers and Carbonaro (2003) designed and developed an alternative, hands-on robotics course for teachers (who would take on the role of students) in the hope that they could implement the robotics course inside classrooms. With two goals in mind, technology integration and a constructionist learning environment, the researchers sought to engage students so that an intrinsic motivation toward STEM would surface. They found that the "teachers, as students, appreciated the constructionist framework . . . and they also found value in the hands-on, activity-based approach" (p. 233).

Nourbakhsh et al. (2005) designed a similar study with high school students. While working with high school students in a seven-week, hands-on robotics class in Mountain View, California, Nourbakhsh and colleagues sought to understand high school students' experiences with robotics and to deeply comprehend robotics as a curriculum. The researchers discovered that robotics created experiences allowing students to have a deeper and more meaningful understanding of abstract concepts. They concluded that the robotics course was able to foster "skills that can prepare students for broad success in technology and science education" (p. 23).

Additionally, Nourbakhsh et al. (2005) analyzed participants' self-reporting data to understand how gender differences impacted the class. Analysis of student self-reports concluded that females were more likely to struggle with the programming, and they entered the course with less confidence in technology than the males; however, they found that female participants' confidence with technology accelerated faster than the male participants. The researchers concluded that the robotics course supported participation; it compensated for initial differences between the females' and males' confidence with the technology.

Furthermore, researchers looked at the impact a more specialized science curriculum could have on actively and effectively engaging students in the classroom (Carlone, 2004; Chambers & Carbonaro, 2003; Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012). Carlone specifically examined "how girls participated within and against [science] meanings" (p. 392). The researcher asked the compelling question: "Does a different kind of school science, one that promoted alternative (and broadened) meanings of what it meant to 'do science' and 'be a science person,' make for a more inclusive and interesting science for girls?" (p. 409). She found that an alternative program did challenge stereotypical science meanings that female participants had prior to their enrollment.

Nourbakhsh et al. (2005) used robotics and discovered that "girls' confidence in technology increased throughout the course significantly more quickly than the boys'" (p. 24). Following the steps of others whose studies also supported improvements in students' attitudes with the use of robotics (Mauch, 2001), several researchers narrowed their focus to females and their attitudes (Notter, 2010; Nourbakhsh et al., 2005; Rogers & Portsmore, 2004). Rogers and Portsmore concluded that robotics "appeared to support the participation of the girls and was able to compensate somewhat for the initial differences between girls' and boys' comfort with technology" (2004, p. 24). Pezalla-Granlund (2005) discovered a persistent need for the recruitment of more young females in robotics.

Tyler-Wood et al. (2012) found that "an effective science program for girls at the elementary level can make a difference in the way females view science and STEM careers as they enter college" (p. 54). Using an after-school program for elementary school children, they were able to provide "authentic learning experiences" (p. 46). With funding from the National Science Foundation, the researchers used a program that involved mentors, weekly science labs, and hands-on activities. They concluded, "the majority of these girls now have a much stronger awareness, appreciation, and confidence with science" (p. 53). Undoubtedly, a number of studies using different types and kinds of science programs exist, but few of these studies seek to deeply understand the impact curriculum can have on middle school girls' experiences and perceptions of STEM-related fields.

Chapter Summary

Chapter 2 began with the theoretical foundation based on critical feminist theory followed by a conceptual framework grounded in three bodies of literature: sexism in the classroom, self-efficacy beliefs and perceptions of STEM-related fields, and robotics as an alternative curriculum. In the first part of the conceptual framework, seminal research on sexism in classrooms was presented. Researchers found that sexism was inherent in teachers' lessons, publishers' textbooks, and classroom learning environments. These sexist situations were found to have an impact on female self-efficacy beliefs and perceptions about STEM-related fields. Especially in adolescent females who were forming their identities, they struggled with self-efficacy beliefs about themselves. Researchers found that the struggles did not stop with self-efficacy, as it carried into a female's perceptions about STEM-related fields, too.

The third part of the literature review explained how several researchers studied robotics as an alternative curriculum for STEM classrooms. From early elementary school to graduate school, researchers looked at robotics as an alternative curriculum to traditional approaches. Some researchers narrowed their research to see how a robotics curriculum impacted females specifically.

A call for researchers to continue the investigation of the impact of robotics exists. Hoping for robotics to be one promising solution, researchers are seeking to understand more fully how robotics can impact females and their opportunities in STEM-related fields.

The sexist classroom, diminished self-efficacy beliefs found in middle school girls, perceptions and experiences with STEM fields, and robotics provided the impetus for this study. With females encountering an array of barriers not experienced by males, it becomes important to understand how females are experiencing and perceiving STEM fields in middle school. Since classroom environments and vicarious experiences, especially during a female's middle school years, can inform how or why a female will pursue or not pursue certain fields, it becomes critical to understand how a female experiences and perceives new-found curriculum at the middle schools. The review of literature validated robotics as a curriculum that academia has studied and has used as a platform for extending STEM initiatives in the classroom.

The review of the literature also informed the continuous need for researchers to support critical feminist theorists. So many believe that the fight for gender equality is over, yet sexist remarks, sexist language, and sexist actions repeat themselves year after year (Sadker & Silber, 2007; Sadker & Zittleman, 2005).

The intent of this qualitative case study was to report how middle school girls in two Southern California classrooms describe the impact of a robotics curriculum on perceptions and experiences with STEM fields. The results of this study will provide educational leaders with insight into an alternative curriculum and the impact a curriculum like robotics can have on middle school girls and their choices in regards to STEM fields.

CHAPTER 3

RESEARCH METHODOLOGY

The problem that this study sought to address is the shortage of girls in science, technology, engineering, and math (STEM) related fields. Studies showed that an increasing number of girls were not choosing STEM-related fields as professions, and the shortage generated questions asking why girls were not choosing these fields. Researchers found that adolescent girls in their middle school years struggled with self-efficacy beliefs, and some researchers pointed to the traditional classroom as a potential reason for the struggle. Several researchers suggested alternative curriculum like robotics as a potential gateway. Researchers started looking at robotics as a viable curriculum that could not only sustain and support, but also salvage a girl's perceptions and experiences with robotics.

The purpose of this embedded, qualitative case study was to investigate the impact of a robotics curriculum on the experiences and perceptions of middle school girls in two California classrooms. The study aimed to determine if participation in a STEM-based, robotics curriculum promoted a classroom free of sexism where female participants could thrive.

According to Agee (2009), "In the end, good qualitative questions are dynamic and multi-directional, drawing the reader into the research with a focus on a topic of significance and at the same time functioning as lenses that are directed outward by the researcher to capture the nuances of the lives, experiences, and perspectives of others" (p. 446). Four questions guided this study:

1. How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?
2. What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?
3. How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?
4. How do two teachers describe the performance of middle school girls participating in their robotics classroom?

In this chapter, the researcher first presents the methodology for the embedded case study including a discussion of the philosophical foundations. Next, the researcher presents the context of the research, the research design, and the research questions. The researcher proceeds to present the participants, the role of the researcher, instrumentation with data collection procedures, data analysis and interpretation, and the validity of the study. Last, the chapter concludes with a chapter summary.

Qualitative Research

Creswell (2013) argues that qualitative research could "transform the world" (p. 44). This claim might seem far-reaching to some, but to others, qualitative research promotes the human experience in ways that quantitative research cannot (Stake, 1995). Human experiences are invaluable and can provide what facts, figures, and statistics might not cover. Through human experiences and the voices of middle school girls, the researcher sought to uncover facts, figures, and stories that could create long-lasting transformations.

Haller and Kleine (2001) compare a researcher's qualitative design, or project, to an architect's blueprint. They suggest that educational researchers solidify strong and sound plans in the same way that a skilled architect would present error-free plans for a freestanding, formidable structure.

Research Design

Creswell (2013) states that the hallmark of a good qualitative study would be the presentation and design of an in-depth understanding of a particular case or phenomenon. Yin (2009) generalizes case studies as research that answers "how" and "why" questions and focuses on "a contemporary phenomenon within a real-life context" (p. 2). Using the contemporary phenomenon, robotics, and the real-life context of today's classroom, the researcher sought to uncover the impact robotics can have on the experiences and perceptions of middle school girls.

Additionally, Yin (2009) explains that case studies attempt to understand complex social phenomena. He further describes how a complex social phenomenon might call for a qualitative case study because the boundary between the phenomenon and the real-life context is blurry (Yin, 1989, as cited in Yin, 2009). The researcher was interested in understanding any complexities that might have existed between the robotics curriculum and the experiences and perceptions of middle school girls.

Stake (1995) has scripted the lines for a qualitative, case study quite succinctly: ". . . we enter the scene with a sincere interest in learning how they function in their ordinary pursuits and milieus and with a willingness to put aside many presumptions while we learn" (p. 1). The researcher of the study entered the scene of two robotics classrooms, made objective observations, wrote about (and quantified) interactions, asked questions of the instructors, found out how middle school girls experienced robotics, and discovered the impact robotics could have on middle school girls' experiences and perceptions about STEM-related fields.

Research Methods

Case study methodology seeks to understand a phenomenon alongside important contextual conditions (Creswell, 2013; Yin, 2009). The contextual conditions can range from the study's surroundings and setting to circumstances and specific reference points. Ultimately, life context adds to a researcher's deep understanding of a particular phenomenon (Yin, 2009). Unlike quantitative methodology, where context becomes "divorced" from phenomena, in case study research, an unlimited ability for investigation presents itself with the potency of context (Yin, 2009, p. 18). The "richness of the context" becomes the numeric "data points" researchers find in quantitative research (Yin, 2009, p. 2).

The plan is to conduct an embedded case study where ". . . within a single case, attention is also given to a subunit or subunits . . . " (Yin, 2009, p. 50).

Because the researcher observed not only the robotics program but also the girls participating in the program, it was important to distinguish the research as an embedded case study. To avoid "slippage" away from the original research questions, an embedded case study allowed for the flexibility of focusing on a set of subunits (Yin, 2009, p. 52).

This study was designed to focus on the robotics program, but mainly through the experiences and perceptions of middle school girls. Stake (1995) asserts, "For the most part, the cases of interest in education and social service are people and programs" (p. 1). Since the researcher sought to investigate the experiences and perceptions of middle school females in a robotics program, as Stake suggests, the focus of the study was on both people and programs.

Context

The study took place at two middle schools in Southern California along the coastline in Orange County. The researcher called the middle schools Newland Middle School (NMS) and Old Orchard Middle School (OOMS). NMS and OOMS are part of a larger district that the researcher called Mission Hills School District (MHSD). MHSD supports 14 middle schools located in eight different cities. The district serves approximately 51,000 students, and the middle school sites, NMS and OOMS, each serve approximately 1,500 sixth-, seventh- and eighth-grade students.

MHSD is somewhat diverse in demographics. According to the district's website, 61% of the students are White, 24.7% of the students are Hispanic, 5.3% of the students are Asian, 1.7% of the students are Filipino, 1.2% of the students are African American, and 6% either declined to state or are less than 1% of the entire population. According to NMS's website, the school's demographics are 60% White, 17% Hispanic, 10.6% Asian, 2% Filipino and 0.8% African American. OOMS's school accountability report card shows the school's demographics are 62.5% White, 22.1% Hispanic, 6.6% Asian, 1.8% Filipino, and 0.8% African American.

Between the two schools, several changes took place in regard to STEM instruction. One of the schools made several changes in the previous 10 years to accommodate the need for 21st century, advanced technology. Between the 2002-2004 school years, two new two-story portables were added to accommodate growth at OOMS, and these new buildings support eight state-of-the-art science classrooms. In the 2007-2008 school year, a new portable computer lab classroom was added. Both schools' websites provide pictures, blog sites, portals, and other online resources. Both websites show the schools' dedication to advancements in the area of STEM instruction.

During the 2012-2013 school year, both schools had robotics teams. OOMS had a robotics club that participated in a VEX pilot program, one type of robotics program. The team consisted of eight males and eight females. Eleven of the students were eighth graders and the other five students were seventh graders. One of the schools had an after-school robotics team with 14 students: 10 boys and 2 girls. As the school year came to a close, some teachers within the district decided to create an engineering section, or elective class, that would be part of their schools' 2013-2014 master schedules. The new class would involve research, design, and construction of robots.

NMS and OOMS are high performing schools with supportive teaching staffs. With an Annual Performance Index (API) above 900, OOMS holds two honorable titles: National Blue Ribbon School and California Distinguished School. Additionally, according to OOMS's website, OOMS teachers endeavor to make each student's learning experience meaningful and relevant, plus they provide many opportunities for students to participate in unique programs such as STEM.

Participants

Stake (1995) suggests that the selection of cases needs to maximize learning. Additionally, Creswell (2013) offers the definition of a participant observation where "the researcher is immersed in the day-to-day lives of the people and observes and interviews the group participants" (p. 90). The participants for the study included 11 middle school females enrolled in two different engineering after-school robotics programs and the robotics teachers who taught the courses. The researcher observed the robotics classrooms on five different days as a participant observer after parents gave full consent and students gave full assent. Additionally, the researcher interviewed 11 female participants and two robotics teachers. Interviews took place on three different days. The researcher gained parental consent and student assent before starting the research. All students and teachers were ensured confidentiality; pseudonyms were used throughout the writing of the dissertation.

The selected classrooms were convenience samples in terms of access and location. Although Creswell suggests that the convenience of time, money, and effort could shortchange information and credibility, with a combination of data points that included documents, interviews, and participant observations, alleviation was possible (Yin, 2009). Plus, according to Miles and Huberman (1994, p. 27), "As much as you might want to, you cannot study everyone everywhere doing everything," so in the case of this research study, the researcher limited the study to a select group of middle school girls and two robotics teachers. This convenience sampling allowed the researcher to gather the data that was needed to further understand the problem.

To protect the participants in the study, the researcher submitted a proposal that detailed the project's procedures and any risks involved to the Institutional Review Board at California State University, Fullerton. Parents consented to the participation of the minors in the study, and students gave the final assent. All participants have pseudonyms within the dissertation. Anonymity and protection of the students, families, school and district was a priority.

Instrumentation and Data Collection

Before any observations or interviews took place, a letter to the district, principal, teachers, parents and students requested permission for the research to take place. The letter provided detailed descriptions on protection of participants' identities and confidentiality of all involved. Formal Institutional Review Board procedures preceded any of the below instrumentation and data collection procedures.

Observations. The researcher conducted five classroom observations. As a nonparticipant observer, she was an outsider to the group, observing while taking field notes. Using observation protocol, two methods took precedence: descriptive note-taking and reflective note-taking. In the same way that Sadker and Sadker (1986) observed the number of times females rather than males were called on by the teacher, the researcher drew direct attention to the number of times females rather than males are called upon in each of the two robotics classroom and the number of times females engaged in the discussions rather than failed to engage in the discussions. Additionally, the researcher looked at the number of times female participants rather than male participants manipulated the robot. Sadker and Sadker (1986) paid close attention to engagement of females versus males, so the researcher also closely observed the engagement of students in the two classrooms. The researcher conducted classroom observations that added to a bank of data needed to generate qualitative information (Stake, 1995).

Interviews. As Stake (1995) suggests, it is the researcher's job to understand that each participant has a different experience to share; hence, each interview needs to have a flexible line of protocol. The purpose of the interviews was to materialize into words the experiences and perceptions the girl participants had about robotics and STEM, as well as to find out about methods for learning in a robotics classroom. A table delineated each research question and was the instrument the researcher needed to use to ensure that she covered each research question. Interviews took place in groups in a private room where the girls answered questions candidly. Each group interview took approximately 45-60 minutes and included approximately 15-20 questions.

The researcher mirrored a strong model set forth by Zeldin and Pajares (2000). These researchers explored the personal stories of females between the ages of 26-53 who were already in STEM fields; they used the female participants' narratives to better understand the ways in which self-efficacy beliefs influenced academic and career choices. The participants described vicarious experiences and social interactions that occurred as early as middle school, and how these experiences influenced self-efficacy beliefs in the area of STEM. The researcher asked the middle school girls participating in the STEM robotics classroom about positive and negative encounters they have had with vicarious experiences and verbal persuasions.

For the current study, the researcher designed instruments using several strategies. First, the researcher looked at related studies and then tested similar instruments on three middle school females who participated in a STEM robotics curriculum. The researcher tested the questions to ensure that the wording of each question would allow participants to answer candidly without hesitation. Second, the researcher followed strategies used by Zeldin and Pajares (2000) where questions covered different time dimensions to ensure that, when appropriate, "a holistic description of each participant and her story" would surface (p. 223). Third, the researcher strategically placed questions in a particular order so that the researcher could gather data on three key concepts:

perceptions and experiences with the robotics curriculum, the learning occurring with the robotics curriculum and perceptions about STEM fields.

In the same way that Zeldin and Pajares (2000) started their interview protocol with questions about family background and participants' occupations to build a bridge between the participants and the researcher, the researcher started the interview protocol with family background and STEM background. The researcher asked the female participants about their families and the careers (or jobs) of individuals in their home or individuals closely related to them. For example, the researcher said, "Tell me about the jobs, or professions, of the adults in your home or the adults with whom you gather (i.e., grandparents, aunts, uncles, or friends)." This type of question eased fears or anxieties that the participants may have had about answering questions, as it tapped into background knowledge rather than new knowledge.

After gathering the data on STEM background and after generating a strong rapport with the participants, the researcher continued to follow Zeldin and Pajares' (2000) model with questions that asked participants to recall experiences. To address the first research question, the researcher paralleled Zeldin and Pajares' study by asking direct questions about STEM experiences and perceptions of a robotics classroom. For example, the researcher asked the middle school girls about experiences that contributed to a desire to be in (or stay in) a robotics classroom. Additionally, the researcher asked about others and how they responded or commented after finding out about robotics participation.

Finally, the researcher asked about a memorable story that represented an experience the students had had in the robotics classroom.

To understand middle school girls and their STEM perceptions, the researcher reviewed Pettitt's (1995) quantitative study that examined 162 students from a suburban Denver middle school. Pettitt used surveys to identify career aspirations, perceptions about society's acceptance of certain career choices for men and women, and relationships between perceptions of their abilities and their desire for certain jobs. Using Pettitt's survey as a model, the researcher asked for girls' perceptions about career choices for men versus women and requested the girls to select from a list of careers and their aspirations versus occupations that were far from their aspirations. Three sample questions with answer choices (explained further below) included:

1. If you could be anything you wanted to be, how much would you like to have each of these occupations?
2. Do you feel that you have the skills and abilities needed to be successful at these occupations?
3. What occupations does society think are okay for women/men to be?

The first question involved "really liking" or "really wanting to be" a particular profession. A series of three additional questions ranged from "kind of want to be" to "would hate being" a particular profession. The participants chose a career from a list of professions (See Appendix E). The second question was asked as an interview question and required the girls to answer candidly about some of the profession choices.

The last question involved occupations and whether or not society felt it was okay for females versus males to be in particular occupations. For Pettitt, the data from the above question supported her conclusion regarding the "sex-typing" of professions. Pettitt discovered that both female and male participants rated society's acceptance of science-related jobs as less accepting for females than males.

The question "What occupations does society think are okay for women versus men to be?" allowed the participants an opportunity to either bridge or not bridge the curriculum questions about robotics with the career questions. The participants spoke candidly regarding perceptions about STEM and how their own and society's perceptions about career choices impacted experiences and perceptions they created while participating in the robotics curriculum.

Additionally, to understand perceptions that middle school girls in two California classrooms had about STEM careers, the researcher adapted a part of Pettitt's (1995) survey that asked the girls to either use "he" or "she" to finish a statement about certain careers. For example, the researcher surveyed with the following six statements:

1. The doctor placed ___ stethoscope on the table.
2. The teacher placed ___plan book on the table.
3. The nurse placed ____thermometer on the table.
4. The surgeon placed ___ scalpel on the table.

5. The scientist placed ___ clipboard on the table.

6. The mathematician earned an award for ___ effort.

The above survey idea stemmed from Pettitt's (1995) study that showed females and males had career aspirations that remained fairly sex-typed.

For the second research question regarding what middle school girls are learning in a robotics classroom, the interview questions mainly followed the example provided by Slangen et al. (2011). Slangen asked open-ended questions and focused on remarks that the students provided. Some dialogue included "What are robots? What are they made of? Do you know other kinds of robots? What makes robotics different or similar with respect to animals or humans? Why do people build robots?" However, the researcher added to Slangen's study a question about similarities and differences between science or mathematics classrooms versus robotics classrooms. The exact question that the researcher asked was "How is the robotics class similar or different to the science or math classroom?"

The researcher interviewed the two robotics teachers from each of the two robotics classrooms. She conducted the interviews after school when the students were not present. The researcher and asked questions that derived from Sadker and Sadker's (1986) findings regarding pervasiveness of sex biases in diverse classrooms taught by male and female teachers. Sadker and Sadker found that "male students were involved in more interactions than female students" (p. 512). Alongside the classroom observations, the researcher also asked the robotics teachers about male versus female participation. Sadker and

Sadker held trainings for teachers aimed at giving teachers an awareness of the sex biases they discovered in the classrooms. Sadker and Sadker noted negative responses teachers made in regard to skepticism of their own professional style and skepticism about having sex biases in the classroom (p. 514). Sadker and Sadker had teachers view videotapes and films of student/teacher interactions. For this study, the researcher used observation notes to generate questions about female versus male participation. Since the initial and immediate observation notes showed that girls participated equally to the boys in the robotics classroom, the researcher asked the teacher to describe the performance of both the females and the males in the classroom. Results from the two teacher interviews helped the researcher understand whether or not a robotics curriculum might support a more gender-neutral environment.

All interview data was recorded on a digital device, and the digital device rested in a safe, locked space. The researcher ensured that all observation notes and interview data were locked away and held highly confidential.

Data Analysis and Interpretation

The worst-case scenario for any qualitative, case study researcher would be not to know what to do with the data upon collecting the data (Yin, 2009). In the same way that an amateur chess player might enter into a game randomly moving pieces in a first turn, second turn, and third turn, not having a strategic plan in mind, a qualitative researcher can easily find herself in a similar predicament. Yin (2009) compares data analysis software tools to having an able assistant or secretary. In the same way that a secretary might use shorthand to transcribe the information onto a longer, more formal memo, data analysis software called Atlas Ti coded the interview and observation data so that the researcher was able to generate conclusions based on the "legwork" of the computer software program. Atlas Ti would "readily locate in the textual data all words and phrases matching [the inputted codes], count the incidence or occurrence of the words or codes, and even conduct Boolean searches to show when and where multiple combinations are found together" (Yin, 2009, p. 128).

Utilizing the suggestion made by Miles and Huberman (1994), the researcher planned the following:

1. Make a matrix with categories and evidence within each category
2. Create data displays, flowcharts, and other graphics for examination of data
3. Examine the complexity of the tabulations and relationships using calculations
4. Put information in chronological order

Yin called the above four steps preliminary steps that a researcher must manipulate, or play with, in order to progress.

Validity

Creswell and Plano Clark (2011) explained the procedures "for checking on the quality of the data, the results and the interpretation" of the qualitative research data (p. 210). It is the researcher's responsibility to ensure that the data that is analyzed is trustworthy and credible, especially with the use of "rich, thick description to convey the findings" (Creswell, 2009, p. 191). With a focus on validity, the researcher made sure to analyze the data using methods such as member-checking (Creswell & Plano Clark, 2011). Creswell (2009) suggested using member checking to ". . . determine the accuracy of the qualitative findings through taking the final report or specific descriptions or themes back to participants and determining whether these participants feel that they are accurate" (p. 191).

Creswell and Plano Clark (2011) gave a second validity measure: triangulating data. They explained, "This procedure is a common data analysis practice: The inquirer builds evidence for a code or theme from several sources or from several individuals" (p. 212). Creswell said that triangulating data builds "a coherent justification for themes" (Creswell, 2009, p. 191). The researcher triangulated classroom observations, small group interviews with students, and personal interviews with the teacher to add validity to the study. She checked with the teacher to ensure the final report and final descriptions and themes were accurate.

Role of the Researcher

Peshkin (1988) warned about the researcher's role and how difficult it is to "escape the thwarting biases that subjectivity engenders, while [at the same time] attaining the singular perspective its special persuasions promise" (p. 21). Peshkin reveals how researchers have an obligation to couple unbiased, objective perspectives alongside passions for the investigation. The researcher created a fine balance between the passion to do the research and the research itself, and it was evidenced in the objective, unbiased data. The researcher used an unbiased lens, with subjectivity set aside.

Peshkin (1985) "discovered [his] subjectivity at work, caught red-handed with [his] values at the very end of [his] pen" (p. 277). The researcher was well aware of the need for objectivity and impartiality to distinguish credible and valid research from invalid research. Peshkin confirms, "Subjectivity can be seen as virtuous, for it is the basis of researchers making a distinctive contribution, one that results from the unique configuration of their personal qualities joined to the data they have collected" (p. 276-278). The only subjectivity that the researcher configured into the investigation is the subjectivity involved with attaining valid and credible qualitative research.

Chapter Summary

This chapter provided the methodology the researcher used between the fall of 2013 and the spring of 2014 to conduct the research. Using a qualitative, embedded case study design, the researcher investigated the impact a robotics curriculum had on middle school girls' perceptions and experiences in STEM fields. Using the research questions to guide the methods for research, order and organization were top priorities. From the context of the study and research questions to the research participants and instrumentation for the research, the researcher conducted the research following a definitive and detailed plan. The data collection procedures were strategic, and the data analysis and interpretation that followed was validated by validation methods.

CHAPTER 4

FINDINGS

This study examined middle school girls' perceptions of and experiences with robotics in two California middle school robotics classrooms. This chapter presents the findings that the researcher discovered through interviews, a questionnaire, and classroom observations. The chapter begins with a restatement of the purpose and the four research questions that guided this study. Next, the chapter presents the demographic characteristics of the participants, the interview data, and the results from the classroom observation tally sheets in an attempt to answer the four research questions. The chapter concludes with a summary.

Purpose and Research Questions

The purpose of the study was to investigate the experiences and perceptions of middle school girls participating in two California middle school robotics classrooms. The researcher wanted to identify whether or not robotics was a viable curriculum to enhance middle school girls' perceptions about science, technology, engineering, and mathematics (STEM–related) fields. Four research questions guided this qualitative case study:

1. How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?

2. What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?
3. How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?
4. How do two teachers describe the performance of middle school girls participating in their robotics classroom?

Demographic Characteristics of Respondents

This qualitative case study included a convenience sampling of male and female participants from two different middle school classrooms in Southern California. Newland Middle School (NMS) is the pseudonym for the robotics classroom taught by the male teacher, whom I called by pseudonym, Mr. Gee, and Old Orchard Middle School (OOMS) is the pseudonym for the robotics classroom taught by the female teacher, whom I called by pseudonym, Mrs. Alerton. Both classrooms consisted of male and female participants whom the researcher observed; however, only the female students were interviewed. Fourteen of the 15 female students participated (six from Mr. Gee's class and eight from Mrs. Alerton's class). One of the female students from Mrs. Alerton's class was not interviewed because she was absent on the day the researcher conducted interviews. In addition to the 14 female participants, who participated in both observations and interviews, the researcher observed and interviewed both the male teacher, Mr. Gee, and the female teacher, Mrs. Alerton.

Both robotics classes took place after school. Mr. Gee taught the NMS robotics class from 3:30 to 4:30 in the afternoon. The class consisted of six girls and 11 boys. The researcher interviewed all six girls on two different days using a group interview setting. Three girls participated in the group on each of the two days. The interviews took approximately 45 minutes to one hour. The OOMS robotics class met from 2:45 to 4:00 in the afternoon with the robotics teacher, Mrs. Alerton. The NMS class consisted of nine girls and nine boys. The researcher interviewed eight girls using two 45-minute sessions on the same day. Each interview (consisting of four girls each) took approximately one hour to finish.

The researcher started each interview with background questions about grade level, number of years in robotics, and immediate or extended family members who participate in STEM careers. Two of the girls were in the sixth grade, six of the girls were in the seventh grade, and five of the girls were in the eighth grade. All of the eighth-grade girls were from Mrs. Alerton's class. Two of the girls from Mrs. Alerton's class had participated in her after-school robotics classroom previously, while all other participants stated that it was their first year in robotics. Using background questions from Zeldin and Pajares' (2000) study, the researcher asked the middle school female participants about immediate and extended family members who currently had careers in STEM-related fields. Nine out of the 14 girls had immediate or extended family members who had participated or currently held a position in a STEM-related career. The range for types of family members was broad (see Table 1):

Table 1

Demographics for 14 Female Students

Participant	School	Grade Level	Years in Robotics	STEM Professions In Family Background
G1*	OOMS	7th	1	engineer
G2*	OOMS	7th	1	engineer; doctor
G3*	OOMS	8th	1	engineer; doctor
G4*	OOMS	8th	2	none
G5*	OOMS	8th	1	engineer; nurse; ultrasound technician
G6*	OOMS	6th	1	none
G7*	OOMS	8th	1	engineer
G8*	OOMS	8th	2	none
G9	NMS	6th	1	engineer;
G10	NMS	7th	1	engineer;
G11	NMS	7th	1	engineer; chemist
G12	NMS	6th	1	engineer
G13	NMS	7th	1	None
G14	NMS	7th	1	engineer; doctor

* Girl participant was in the female teacher's robotics classroom.

Research Question 1

The researcher sought to answer the question: How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences? The researcher asked the 14 female participants four questions about their experiences with robotics:

1. Who decided that you would be in a robotics class?
2. When is the first time you remember hearing about robotics?
3. What did you know about robotics before taking this class?
4. Can you describe a memorable event that has happened in the robotics classroom?

Who Decided That You Would Be in a Robotics Class?

The first question the researcher asked the girls involved their enrollment in the robotics class. The researcher asked whether or not the teacher, parent, or the student decided to enroll them into the robotics class. Thirteen girls responded with "I decided," while one girl referred to her family, teacher, or peers as codependent decision makers: "We all decided. It was our own decision if we wanted to join this program." Ten of the girls mentioned or referred to friends or family members as added reason for deciding to be in a robotics program. Seven of the girls used the word "fun" or "cool" to describe the reason why they joined (see Table 2).

Table 2

Who Decided That You Would Be in a Robotics Class?

Participant	Personal	Family	Friends	Added Descriptors
G1*	X			I pretty much decided. It sounded really fun, and it had a lot of cool looking stuff...
G2*	X			I decided...it sounded cool.
G3*	X			We all decided...it was our own decision if we wanted to join this program.
G4*	X			I decided because I was on the team last year so I just wanted to continue going.
G5*	X	X		I kind of decided because, my brother was also doing it, and my mom kind of wanted both of us to do it, but I also wanted to do it.
G6*	X	X		I think I decided because, um, I was the one who wanted to do this, the robotics, because I thought it would be really fun, and it is; and, because my parents thought it would be really fun, too.
G7*	X		X	I decided to do the robotics because some of my friends did it last year, and from what they told me, it sounded really fun; so, I decided to join this

G8*	X	X		Oh, well, my brother did it last year, and he really liked it and I thought it would, like, help with academics and like learning new things and going to colleges and stuff.
G9	X			Engineering and robotics is something I've enjoyed since I was little.
G10	X		X	I wanted to do it because it was a fun thing to do with my friends and it was a great way to meet new people.
G11	X	X		I've always been kind of interested in technology, and a lot of my family are, like, car engineers, and so I thought, wow! I get to see what they're doing, so I signed up for it.
G12	x	x		I told my mom about it, and she said, 'Sure, go ahead.'
G13	x	x		I told my parents and they said it was a good idea.
G14	x			I thought it was cool.

* Girl participant was in the female teacher's robotics classroom.

When Is the First Time You Remember Hearing About Robotics?

When the researcher asked a question about the participants' first time hearing about robotics, three out of the 11 participants expressed that one of the teachers told them about robotics, three students referred to friends telling them about robotics, and eight students referred to a meeting, sign or announcement. Two participants enthusiastically mimicked the morning announcement that they heard at their school: "The robots are coming! The robots are coming!" One of the two participants added her reaction to the school announcement:

> That sounds fun, because you get to . . . travel and learn how to build things and learn how things work and learn how everything connects and everything has a purpose and there's not just one random like pin or one random piece, in a place where you don't need it to be. So, I heard that you get to do all this cool stuff, and you get to compete in challenges, and so I thought that sounded really fun.

A different participant mentioned the competitive spirit that she observed in other girl students who were enrolled in robotics, and she explained how the other girls' excitement created a contagious effect, "I remember [robotics members] left to go compete for the championships, and [a girl] was really excited about it, and it seemed cool that they were all interested in it and they loved it."

The researcher sought to further understand the girls' experiences with robotics by asking what the girls remembered hearing about robotics and asking about discussions they might have had with parents or friends. Nine participants expressed that they talked to their friends about the robotics class. Nine of the girls talked about how they decided to take the robotics class with friends who had either participated in the previous year, or they were planning to participate in the coming year, while five of the girls did not mention friends at all. All eight girls in Mrs. Alerton's class talked about "friends" joining robotics or talking about robotics, and two of the six girls in Mr. Gee's class talked about friends being a factor in hearing about robotics (see Table 3).

Table 3

When Is the First Time You Remember Hearing About Robotics?

Participant	Responses
G1*	I talked to my friends.
G2*	I told my friends about it.
G3*	Well, I guess, I talked to my parents about it and my friends. I had some friends on the team last year, and they really enjoyed it. And, they encouraged me to join, and so...
G4*	I talked to my parents, of course, to ask if I could fit it into my schedule. And, I also talked to my friends because a couple of them were on the team last year and are on the team this year.
G5*	I did talk to my parents and friends about it. I also talked to my friends because a couple of them were on the team last year and are on the team this year.
G6*	I did, too, and actually, one of my friends is in here, but she is absent today, and a lot of my friends think it's cool, and they wished they had signed up, but they are going to next year.
G7*	I talked to my friends and I had, like, wanted to do it, and so had a lot of [my friends], so we just decided to do it together, and my parents said it was completely my choice, so yeah.
G8*	I also thought it would be...a lot of my friends were planning on joining it...a lot of my friends are in it now...
G9	So, I heard about robotics when my friend came up to me...
G10	So, my friends and I, we decided...
G11	I heard about it when it started last year, and I thought it sounded pretty cool to join. But, I was already in another club, science club, and I just didn't want to have the task of juggling both things back and forth, so I am just like I'm going to try it next year.
G12	I told my mom about it, and she said, "Sure. Go ahead."
G13	...I just did it, and I told my parents and they said it was a good idea.
G14	...I thought it was cool. It sounded like a good idea. I wanted to try something new.

*Girl participant was in the female teacher's robotics classroom.

What Did You Know About Robotics Before Taking the Robotics Class?

When the researcher asked this question, 11 girls had background knowledge that included descriptors that dealt with competing, building, designing, programming, experiencing, and controlling while three of the girls said they really knew nothing before entering. The three girls who knew nothing came from Mr. Gee's class. The three girls who "didn't know anything" added comments suggesting they "really never had any experience with [it]." A different girl added,

> I didn't know much about it. I had seen robots in movies and stuff, but I really never knew how they worked. And, then, being in this helped me figure out all their intricacies and what was needed to make a robot function properly.

The girls' responses to the question can be found on Table 4.

Table 4

What Did You Know About Robotics Before Taking the Robotics Class?

Participant	Participant Response
G1*	I knew they had competitions.
G2*	I knew they...built robots...
G3*	I knew you work with a team to build a robot...
G4*	A bunch of scientists and engineers designed robots and built them.
G5*	Scientists and builders and stuff were creating these robots
G6*	A lot of programming involved
G7*	A required intellect and experience.
G8*	I knew we were going to build stuff...build a robot...compete in a challenge...design.
G9	[I knew a] bunch of motors involves and wires and you control them and they have brains and all that...
G10	I only knew the basics like the plates, axles, the wheels, the motors, and the brain.
G11	... You can turn it into this almost living thing that uses wires and motors to operate and that can move and it can pick up ...
G12	Um, I didn't really know anything about technology, I mean, I've taken technology classes in school before, and stuff like that, like science clubs, and stuff like that, but really nothing about robotics.
G13	I really didn't know that much either. I really didn't know anything."
G14	I didn't know anything.

*Girl participant was in the female teacher's robotics classroom.

Can You Describe a Memorable Event That Has Happened in the Robotics Classroom?

The researcher asked the girls to describe a memorable event that happened in the robotics classroom. Every girl had a memorable event. Ten girls mentioned finished products or competitions. Seven of the girls who mentioned a finished product or a competition were from Mrs. Alerton's class; three girls from Mr. Gee's class mentioned a finished product or a competition. Three out of six girls in Mr. Gee's class mentioned an incident that happened with boys as their most memorable experience (see Table 5).

Table 5

Can You Describe a Memorable Event That Has Happened in the Robotics Classroom?

Participant	Responses About a Memorable Event
G1*	I got six balls in one bin at a time, and I did it in less than 30 seconds. And, all the boys were like, 'Yeah,' and it was fun.
G2*	We finished building the robots, the finished product. That was pretty cool.
G3*	We had a scrimmage before the actual tournament. And, on the day of the scrimmage, we hadn't even finished our robot. We had to do last minute adjustments and stuff. We didn't do so great in the tournament, but it worked; and, that was exciting.
G4*	Our team got second place in the scrimmage. We had amazing drivers. The twins were great with that.
G5*	I remember at our first scrimmage how I saw that our 33 B, that team's robot, was doing really good and getting a lot of points and we got second place.
G6*	I remember when they first took the robot out for a test drive, but it didn't fully work; so, they kept working on it.
G7*	I remember learning how to control the robot for the first time.
G8*	I remember once we built a chassis and it just worked, and we did it all correctly.
G9	We went to the qualification rounds up in Orange, CA, and it was really great because I was the driver, and I got up there, and even though it felt like all the pressure was coming down upon me, it just, like, it was so great because we came out 17th out of 36 people. We didn't advance to the next, but I felt pretty cool about it.
G10	I couldn't go to the qualifier because I was visiting my grandparents in LA for Chinese New Year, but I got updates through text and email, so I got to know that we were doing good. One memorable

	moment was when we built the chassis and we attached the motors to the brain, and it made it move. And, I felt so great. We made so much progress. It had wheels, and it was moving!
G11	The most memorable event for me was when we took the robot apart. I just love, like, the class, and all, and I have to ask, is it really over? I want to keep doing it. I want to see my robot. We got 17th, and I want to see what more we can do.
G12	When one of our robotics team members quit because I remember he pretended that he had to retake a test, but we found him on the blacktop playing.
G13	Yeah, that, and also, this guy on our robotics team, David, he like said that he bust his kneecap, and now he's on crutches, so he had to leave.
G14	One time, we had to take apart our robot because we were doing it all wrong, and it just wasn't really working out, and then, there were a lot of kids that, for example, that kid David, he would walk around with a ruler. And, there were other kids who would play on their phones.

*Girl participant was in the female teacher's robotics classroom.

Research Question 2

The researcher proceeded to her second research question, "What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?" She asked the girls a series of five questions:

1. What are robots?
2. Do you know other kinds of robots?
3. Why do people build robots?
4. Is the robotics class like your science and math class or different?
5. How is it like another class and/or how is not like any other class?

What Are Robots?

When the researcher asked the participants the question about robots, two of Mrs. Alerton's students passed, three of Mrs. Alerton's students had one sentence answers that spoke to a robot's ability to do certain jobs, and three of Mrs. Alerton's students used the word "help" to describe what a robot is. All six of Mr. Gee's students had answers about robots, and they used descriptors that ranged from "computer" and "machines" to "system" and "rover" (see Table 6).

Table 6

What Are Robots?

Participant	Response
G1*	Robots are basically anything.
G2*	No answer
G3*	A robot is something that works mechanically to do a specific job.
G4*	Passed
G5*	They are anything that helps us accomplish something…
G6*	I think robots are just basically, things, like, even a laptop is kind of like a robot and they help us to do things for like school and other stuff that we have to finish.
G7*	Robots are things that can go past human limitations and assist, like people, in doing stuff better than they could themselves.
G8*	I think robots are things that are, like, independent and they don't, like, machines that are independent, and do things on their, sometimes can do things on their own to help humans do things.
G9	Robots are basically computers, um, they are parts attached to a computer basis that operates them. The motors are what make the robots move, and this computer basis has programmed parts. So, this is pretty much a programmed object that you're moving. It's not exactly programmed, but we are driving it and it is just something that is moving at your command. It's something that is supposed to make life easier for you.
G10	I agree, and it's part of the family of iPads and iPhones that makes life easier for you, but it can also do things that sometimes we can't do, for example, the rover that went to mars is a good example because we don't know if mars is safe to go on. But, we have gone to the moon, we have gone to different planets, but we don't know about mars because we don't know much about mars, and so robots can do kind of what we can. They can do things as speed. They can do things at high temperatures, or high pressures or low pressures and high or low temperatures, and it helps us with those things, to

	research, to find out more, and to make films, to do things that can entertain people or fascinate people or give people wonder about what they see.
G11	Robots are machines that are meant for like a specific purpose, like she said, to do things that we can't do or to do things that we don't want to take the time to do. Or, just, we could be doing something else. Like in factories, they are sometimes used to sort out, say, jellybeans or put packaging together, things like that. They're just a lot of part put together to carry out business.
G12	Robots are basically an object with a system or program in it that can do something without using manual power. Robots are basically made of motors and gears and just parts that can connect together and make a system.
G13	Like, they are made out of gears and building tools. They are something that you can control if you want something to happen, and you can control it to do that.
G14	Yeah, they are made of gears and other parts, and they are used to doing a certain job that maybe we can't do fast enough.

*Girl participant was in the female teacher's robotics classroom.

Do You Know Other Kinds of Robots?

The researcher proceeded to further understand what the female participants were learning in robotics, so she asked about whether they knew any other types of robots. Twelve out of the 14 girls mentioned other kinds of robots, which included robots used for the military, medicine, transportation, and other household uses. Six of the girls were in Mrs. Alerton's class, and six of the girls were in Mr. Gee's class. Two of the 14 girls answered, "I don't think I know any" or did not mention any other types of robots, and both of these girls were in Mrs. Alerton's class (see Table 7).

Table 7

Do You Know Other Kinds of Robots?

Participant	Response
G1*	Well, I've seen many different kinds of robots at the scrimmages and stuff. And, some of them look really cool and you can do things that our robot can't...
G2*	Um, yeah, robots made of metal that do other jobs, like, digging up bombs.
G3*	We went to, what was that, ID Robotics, and then they did things for the military, and they were building robots like that, like one that sensed bombs, or one that follows the soldiers, and one who can carry about a thousand pounds, and it followed you around wherever you went, and it was built to go over rough terrain and stuff. And, robots, we use them all the time.
G4*	Well, the ones used in medicine and the military; and even the simple calculator or smartphone.
G5*	Well, I know, of like autonomous robots, like the driverless cars, or, um, and also just like household things like laptops or iPads, or whatever like that.
G6*	I don't think I know any.
G7*	Um, just like simple technology I think like calculators and phones and stuff can be considered robots.
G8*	Um, the stuff they use in the military, like, to detect, like harmful substances and stuff.
G9	There are human applications which makes human movements much easier. So, that would be applying something to the brain that helps your body do something that it was already able to do. And then, there are luxury robots which are, like, iPods or microwaves. That's luxury robots...
G10	I've seen robots. They have one at display on Disneyland actually. Some kind of robot sponsored by Honda, the car company. It is a robot that can function and talk like a human, and it was really cool when I saw it, they had it in Tomorrowland, of all places, and tomorrowland is one of my favorite places, and they had this robot in a building, and it was about 5 foot tall, and it could walk by itself, and it had a face, and it could move its hands and fingers individually, it could move its arms and it could walk at a pace where you could see

	if it was a shadow, and you could probably put a tarp over it and it still moved around.
G11	Yeah, and there are also service robots, like cars for example, because they have wheels and motors and chassis and they all move because of a power source.
G12	Um, I've heard of Assimo. One of those robots that Honda made that can walk and stuff. Yeah, that's all I know.
G13	Not really, just in the movies like C3P0 and R2D2.
G14	Not really, I've just heard that someone made a robot that can navigate its way through a maze.

*Note. *Girl participant was in the female teacher's robotics classroom.*

Why Would People Build Robots?

When the researcher asked the question about why people build robots, 12 out of the 14 girls referred to people building robots so that the robot can perform in a way that humans are not able to perform. Two of the girls in Mrs. Alerton's class passed, and they did not give answers to this question. Twelve of the 14 girls referred to robots as enhancers that "help" and "assist" to make life "easier" or "better" (see Table 8).

Table 8

Why Would People Build Robots?

Participant	Response
G1*	Passed
G2*	...to help us do things that we would normally not be able to do.
G3*	Yeah, to help us accomplish tasks that we can't do on our own or to make something more efficient to make things easier, much easier.
G4*	... people build robots to help them in certain areas of their lives.
G5*	...so that they can advance towards better, like, advances in the future...so that they can be lazier and not do... as much.
G6*	... for assistance...so we don't have to do all the work so they can help us. And, for like productivity, and doing things people can't do.
G7*	I think robots are used to, like, do simple things that us humans can do, but help us, so that we don't have to do them.
G8*	Passed
G9	...to just make life easier for them. It's just an application to what humans can already do. It's just making their life easier.
G10	...to really see how far we can take technology—see how many things we can do with [robots].
G11	We're making life easier...we also build robots also for entertainment...to entertain people...you can do so many things with robots to help entertain people.
G12	To make things more efficient and faster, and overall, easier.
G13	Yeah, I was going to say easier, maybe quicker, they don't want to do something themselves.
G14	Yeah, I was going to say that [pertaining to G13].

*Girl participant was in the female teacher's robotics classroom.

Is Your Robotics Class Like Your Science and Math Class or Different?

The participants had mixed responses when the researcher asked about whether or not the robotics class was similar or different to their science or math class. The first group of girls from Mrs. Alerton's class saw a few more differences than similarities. The first participant said, "It's different. It's a lot more fun. You can talk a lot more. You can communicate with the other girls and boys, and it feels like you can do whatever you want." Her friend added, "It's not like [a classroom] because it's hands on and you get to build and control a robot. And, it's very social—you get to talk with everyone." Another teammate added,

> Well, while there is math and science incorporated in this, you do kind of get to work together more, and when you're working together, there's more ideas, and you can kind of have a, uh, broader view, I guess, on your, on what it really is. And, come up with things and think of things that you couldn't really do by yourself.

When the researcher asked the second set of girls from Mrs. Alerton's class the same question, the first girl started with the similarities. She said, "It's very similar because I actually have no way to touch the robot at all. Um, I got to do the research project. The research project is a bunch of research, some mathematics and science, and everything that goes into an already invented robot." A different participant from Mrs. Alerton's class added a main limitation she saw in a classroom: "I think it's similar because it's basically the same, like, aspects I guess, but it's different because we're all working on, like, just one project, and with science or math, we're just focusing on the book."

Two girls from Mrs. Alerton's class noted the methods of application of the math and science concepts in the robotics class versus the classroom setting, and how it's similar and different because application is the greater focus. The first explained, "I think it's similar [to math and science class] because sometimes you might run into a thing where you might have to use math, and you also might have to, you also might learn about something else that has to do with science that has to do with your project." Her friend added, "I think the learning in itself is different because we do most of the work on our own and find our own stuff whereas in classrooms it's mostly presented to us." Another participant explained, "... it feels like, more our own, now that we really looked into it ourselves. We care about it. We do things more on our own. There isn't much guidance from the teacher, whereas in science in math it's more guided and there's an actual curriculum to follow."

Five out of six girls from Mr. Gee's class focused on the parts of science or math class that seemed the same as robotics. For example, one participant noted,

> It's different, though it's using the same things that you learned, and applying it to what robotics is. For example, math, you need to calculate the angles and the measurements and that's applying to robotics, and with science—physics—you need to apply physics, like, the point of balance, and so on. And, that applies to both math

> and science, and to technology. And, that's basically what technology is, is math and science with engineering in it.

Another girl from Mr. Gee's class added,

> But, physics, or physical science, which is what you learn in eighth grade, there are some eighth graders who are doing that right now, and um, that's how it relates to them. That's kind of what they are learning right now. If you look at the eighth grade textbook, it is the Mars rover; it is a picture of a rover that goes into space.

The last participant added more specifically, "Robotics is more like motion, and like, laws of motion and gravity. Like how can this how strong does this claw have to be to pick the robot up, defy gravity, because it's really heavy, and how fast does it need to go based on those and what can make it go faster" (See Table 9).

Table 9

How Is the Robotics Class Similar to or Different From Your Science or Math Class?

Participant	Similarities	Differences
G1*		It's different. It's a lot more fun. You can talk a lot more. You can communicate with the other girls and boys, and it feels like you can do whatever you want.
G2*		It's not like [a classroom] because it's hands on and you get to build and control a robot. And, it's very social—you get to talk with everyone.
G3*		Well, while there is math and science incorporated in this, you do kind of get to work together more, and when you're working together, there's more ideas, and you can kind of have a, uh, broader view, I guess, on your, on what it really is. And, come up with things and think of things that you couldn't really do by yourself.
G4*	For me, it's very similar because I actually have no way to touch the robot at all. Um, I got to do the research project. The research project is a bunch of research, some mathematics and science, and everything that goes into an already invented robot.	
G5*		In robotics, we do things more on our own. There isn't much guidance from the teacher, whereas in science in math it's more guided and there's an actual curriculum to follow.
G6*	I think it's similar because sometimes you might run into a thing where you might have to use math, and you also might	

	have to, you also might learn about something else that has to do with science that has to do with your project.	
G7*		I think the learning in itself is different because we do most of the work on our own and find our own stuff whereas in classrooms its mostly presented to us. I'd say, but it feels like, more our own, now that we really looked into it ourselves. We care about it.
G8*	I think it's similar because it's basically the same, like, aspects I guess,…	… but it's different because we're all working on, like, just one project, and with science or math, we're just focusing on the book.
G9		It's different…with science—physics—you need to apply physics, like, the point of balance, and so on.
G10	…But, physics, or physical science, which is what you learn in eighth grade, there are some eighth graders who are doing that right now, and um, that's how it relates to them. That's kind of what they are learning right now. If you look at the eighth grade textbook, it is the mars rover, it is a picture of a rover that goes into space.	…in seventh grade science, its life science, its about humans, it's about animals, it's about adaptation and endangerment, and environments, but, it also, when you're in sixth grade, its about earthquakes, mountains, and landslides, and its not that's not what I like to do. I like life science.
G11		Robotics is more like motion, and like, laws of motion and gravity. Like how can this how strong does this claw have to be to pick the robot up, defy gravity, because its really heavy, and how fast does it need to go based on those and what can make it go faster.
G12	I would say it's like my science and math class because, I mean, you have to think about	

	physics, like, how is this thing going to work, is it going to be weighed down too much by weight, or it's going to be too light, or...	
G13		G13: Um, it kind of is, but it's more hands on, like you experience it. Like, if you do something wrong, you won't do it again, and you can learn from it. Sometimes you do labs in science, but mostly, you're writing.
G14		I would say that the way you learn it is different because you do it yourself, and then, you kind of learn, 'Oh, I have to do this if I want this to happen.'

*Note. *Girl participant was in the female teacher's robotics classroom.*

How Is Robotics Like Another Class and/or How Is Not Like Another Class?

The researcher asked a question similar to the previous question, but this time she did not mention the words *math* or *science*, but asked, "How is robotics like another class and how is robotics not like another class?" Six of Mrs. Alerton's eight students mentioned the word "work." Three of the girls simply mentioned the "work" involved in robotics while three of her students mentioned "group work" or "working together." One of her students passed, and one of her students mentioned how the learning is similar, but the fact that "you get to choose" is different. Four of Mr. Gee's students mentioned differences, one student passed, and two students mentioned similarities. Two of Mr. Gee's students mentioned the learning as similar and different. One girl mentioned that "it's obviously on a different topic, and you are learning about different things and different aspects of science . . . ," while another girl explained how the robotics class is similar in that "you get to make things [and] build things." See Table 10 for all participant responses.

Table 10

How is Robotics Like Another Class and How Is Robotics Not Like Another Class?

Participant	Similarities	Differences
G1*	... It makes you work.	None
G2*	"...You have a limited time to do something, and you have to work your hardest to complete it.	...you're all working on the same thing, and you're all contributing to one thing that's going to represent us.
G3*	... You're still learning a lot in VEX like you would in another class.	...you get to choose whether it's something you want to do or not.
G4*	Passed	Passed
G5*	...we have to do group projects...	...we aren't doing any bookwork or lessons."
G6*	... We are doing group work with other people...like in a [class] project...	... you have to design the robot yourself rather than have it presented to you.
G7*	None	...you mostly get to do your own work and it's more hands on, and you get to work in groups more than you do in class and we do more research.
G8*	...the students have to work together and rely on each other...	...not as much guidance from the teacher...more group work.
G9	I am applying [last year's science] in the robotics class	...I am learning about earthquakes [in class].
G10	Passed	Passed
G11	none	...it's obviously on a different topic, and you are learning about different things and different aspects of science...
G12	...It's like another class because you get to make things, build things, and you get to learn how to make	

	things, you know.	
G13		I don't think any of my classes are really like that. Like orchestra is nothing like that. And, my other writing classes are not hands on and stuff.
G14		I think it's pretty different because in a way we kind of learn faster than we do in other classes because we kind of just like learn, like, we learn in a different way, like we have to teach ourselves and we use that knowledge to do more things.

*Girl participant was in the female teacher's robotics classroom.

Research Question 3

The researcher sought to investigate middle school girls' perceptions about STEM careers using the third research question: How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers? The researcher used a questionnaire, fill-in-the-blank questions about the girls' career preferences, and three open-ended questions:

1. Do you feel that you have the skills and abilities needed to be successful at these occupations?
2. What occupations does society think are okay for men and women to be?
3. What perceptions of STEM careers do middle school girls enrolled in a robotics curriculum have?

Questionnaire

Using conclusions drawn from Pettitt's (1995) study, "Middle School Students' Perceptions of Math and Science Abilities and Related Careers," the researcher used two types of questionnaires. The first questionnaire was based on Pettitt's study of 162 middle school students. Her conclusions identified five different types of career clusters: female sex-typed (child care worker, hair stylist, nurse, social worker, and teacher); male sex-typed (airline pilot, construction worker, professional athlete, professor); doctor/veterinarian (doctor, veterinarian); science related (chemist/physicist, computer scientist, engineer, natural scientist/environmentalist/biologist; and, non-sex-typed (artist/musician/actor, business manager, lawyer, writer/journalist). The researcher proceeded to discover whether or not middle school girls participating in a robotics curriculum clustered careers in the same way. Additionally, the researcher sought to understand middle school girls' perceptions using a survey where the students had to fill in a blank with the pronoun "her" or "his." Each pronoun linked with a particular profession.

To start the interview questions, the researcher handed each girl a questionnaire that had six professions mentioned within six different simple sentences listed (see Appendix F). The professions that each simple sentence mentioned included the following: doctor, teacher, surgeon, singer, scientist, and mathematician. Each sentence had one blank spot for the word *his* or *her*. The researcher read aloud the directions that were at the top of the page. She said, "Place the word 'his' or 'her' in the space provided." Additionally, the researcher asked each girl to "write the first word that comes to mind." The "doctor" and "mathematician" received the most "his" responses from the girls with 10 girls perceiving doctors and mathematicians to be men. The "surgeon" received the next most "his" responses with nine responses from the girls suggesting that nine of the 14 girls perceive surgeons to be men. The "scientist" received seven "his" pronouns. The "teacher" and the "singer" professions both received 0 "his" pronouns, as all 14 girls perceived these two professions as professions held by females (see Table 11).

Table 11

Participant Response to questionnaire Asking for the Word "His" or "Her"

Profession	Doctor	Teacher	Surgeon	Singer	Scientist	Mathematician
G1	his	her	his	her	his	her
G2	her	her	his	her	his	his
G3	his	her	her	her	his	his
G4	his	her	her	her	his	his
G5	his	her	his	her	her	her
G6	his	her	his	her	her	his
G7	his	her	her	her	his	her
G8	his	her	his	her	his	his
G9	his	her	her	her	her	his
G10	his	her	his	her	her	his
G11	her	her	her	his	her	his
G12	her	her	his	her	her	his
G13	her	her	his	her	his	his
G14	his	her	his	her	her	her

*Note. *Girl participant was in the female teacher's robotics classroom.*
Participant Response to questionnaire Asking for the Word "His" or "Her."

Questions about the girls' career preferences. The researcher showed the girls a list of 19 professions that came from Pettit's study that sex-typed professions. The list had all professions randomly listed with no particular or specific order, and sex-typed titles were not mentioned anywhere on the list (See Appendix F). The researcher asked the girls to select one of the listed professions as a profession that they would "really like to be," and the researcher also asked the girls to pick a profession that they "would kind of like to be." All of the girls responded with professions that ranged in the female sex-typed, doctor/veterinarian, science related, and non-sex typed lists. None of the girls selected a male sex-typed profession as a profession that they would "really like" or "kind of like" to be. Three girls selected a female sex-typed profession as their "kind of like to be" profession while 11 of the girls selected doctor/veterinarian, science related, or non sex-typed professions as professions that they would "really like" or "kind of like" to be (See Table 12).

Table 12

Career Preferences: I Would "Really Like to Be" and "Kind of Like to Be"

Participant	Profession "Would Like to Be"	Profession "Would Kind of Like to Be"
G1*	Vet	Scientist
G2*	Artist	Engineer
G3*	Engineer	Psychologist
G4*	Writer/Journalist	Engineer
G5*	Chemist/Physicist	Social Worker
G6*	Computer scientist	Lawyer
G7*	Teacher	Nurse
G8*	Writer/Journalist	Veterinarian
G9	Engineer	Computer Scientist
G10	Animator or Artist	Biologist
G11	Musician	Computer Scientist
G12	Engineer	Natural Scientist
G13	Engineer	Business Manager
G14	Natural Scientist	Professor

When the researcher asked the girls about the professions that they "would not like being" or "would hate being," several of the girls chose male sex-typed professions. For example, one girl asserted, "I would not like being a professional athlete," and another girl asserted, "I would not like being an airline pilot." Several girls chuckled when a last girl asserted, "I would not like being a construction worker." Five of the girls chose male sex-typed careers as careers that they would "hate" being: "airline pilot," "construction worker," and "professional athlete" (See Table 13).

Table 13

Career Preferences: I Would "Not Like Being" and Would "Hate Being"

Participant	Profession "Would Not Like Being"	Profession "Would Hate Being"
G1*	Lawyer	Airline Pilot
G2*	Nurse	Doctor
G3*	Hair Stylist	Doctor
G4*	Professional Athlete	Doctor
G5*	Veterinarian	Doctor
G6*	Hair Stylist	Construction Worker
G7*	Doctor	Construction Worker
G8*	Construction Worker	Hair Stylist
G9	Veterinarian	Hair Stylist
G10	Airline Pilot	Professional Athlete
G11	Hair Stylist	Construction Worker
G12	Teacher	Hair Stylist
G13	Airline Pilot	Hair Stylist
G14	Hair Stylist	Hair Stylist

Do you feel that you have the skills and abilities needed to be successful at these occupations? When the researcher asked whether or not the girls felt that they had the skills and abilities needed to be successful at the listed occupations, 10 of the 11 responded with one of two responses: "I probably have the average [abilities]" or "I do have the abilities." The one girl who did not feel that she had the abilities responded,

> I think some more than others because, like, I already have lots of knowledge with, like, the arts, music and acting, because that is what I really like to do. But then, I think it'd be hard to be something like an airline pilot and construction worker; or, like a lawyer because I would have to learn all the rules for those (see Table 14).

Table 14

Do You Feel That You Have the Skills, or Abilities, To Be Successful at the Professions Listed?

Girl	Response
G1*	I probably could do them if I tried my hardest, but it would be hard to be a business manager.
G2*	Um, Um, I think that, I do, and the hardest would be a computer scientist.
G3*	Yes, I do. And, I think that if I try hard enough I could definitely pursue my goals. I know it would definitely be difficult to be, like a business major or an engineer, but I feel that if I worked at it, I could achieve that goal.
G4*	Probably, if I worked a bit hard to develop some. I could probably be any of those. The hardest to be would be the professional athlete.
G5*	Well, yeah, I am sure I have some of the skills, except, I need to actually do some of these things in order to actually notice them. It would be hard to be a business manager, airline pilot, or construction worker.
G6*	I think I probably have the average, but there's a lot I would have to work at because I don't know how to do many of them. I would have to work at being an airline pilot, veterinarian, or hair stylist.
G7*	I think some more than others because, like, I already have lots of knowledge with, like, the arts, music and acting because that is what I really like to do. But then, I think it'd be hard to be something like an airline pilot, and construction worker; or, like a lawyer because I would have to learn all the rules for those.
G8*	I think I have the basic abilities, but not all of them. I would have to work at being a doctor, airline pilot, or hair stylist.
G9	Yes, I do, because I am smart enough to do it, and I have the guts, and I have to just work hard at it.
G10	I think I do, because grades of course, and of course, I am an artist, technically, and I am trying to get into an art high school, I am trying as hard as I can to do what I want to do.
G11	I think I can. I know how hard it is to be a musician and all, and if you keep trying at it, you can do anything.
G12	Kind of. Because I really don't have experience being a business manager, child care worker, or hair stylist.
G13	No, but you can learn it easily. If you want to be a nurse, you can learn about the body.
G14	I think I could do it if I learn more about it. Just learn more about it.

Note. **Girl participant was in the female teacher's robotics classroom.*

What occupations do society think are okay for women to be and vice versa? When the researcher asked about society's acceptance of certain professions over others for men or women, all 14 of the girls chose Pettitt's female sex-typed careers as professions that society feel are okay for women.

Four of the girls had lengthy explanations for their choices. One girl focused on the stereotypes that she felt society engendered,

> Well, I think, stereotypically, society will think that women will become musicians, veterinarians, or hair stylists, or something really girly, but I'm saying that society is capable of having any gender for any job, and I don't think they'll object against that, I think they'll actually open up to that because in fact, not a lot of people want to be stuff, like engineers or computer scientists, not a lot of girls want to do that, so I think that they would really want to change, in gender, and I think society would be open to that.

One of the girls felt that girls did not have enough forethought on the idea of occupations, and she responded,

> Well, first of all, there's a lot of girls at my school, I have a feeling that they don't know what they don't know what they want to do when they're older, they don't think about what they want to do when they're older, they're living in the moment. They're living in the moment, but, living in the moment is good, like I do that, too, except I think about what I want to do, what my plan is, so that I don't stumble over myself when I think to myself, what college do I want to go to, Oh, I don't know what I want to major in because I don't know what I want to be. So, that's kind of what I think is happening now. As far as that goes, 2013-2014 has been a time of a lot of girls being more incorporated on Instagram; I don't have an

> Instagram, but they don't know what they want to do. As I said, we are in an age of women doing great things. You have many women of the past inspiring woman of today to do things that society is encouraging us to do. But, if there's a construction worker job, they expect men to try out for that than woman.

A third girl felt that her past experiences helped her formulate the jobs that were more accepted than others for females,

> Well, woman generally are hair stylists, because when you go to the barber shop, its mainly girls who do that. I also think, maybe, secretaries. My dad is an attorney, and his secretaries are mostly girls. But there is also, the people who dress up as Disney princesses at Disneyland. You can do that as a summer job, but you don't want to be in those hot costumes.

Another girls explained how her view on what society could think of woman as "pessimistic":

> I think they think more towards actresses and models and teachers. Not to be pessimistic, but, I mean, when most people think of women and girls, they think about looks, beauty, and like, taking care of, like, kids, and not so much of, like, brilliant scientists, rulers, and presidents.

When the researcher asked the girls about society's views on men, and which occupations were okay for men, the girls responded with all four of Pettitt's male sex-typed professions: airline pilot, construction worker, professional athlete, and professor. Some of the girls added other professions to the list of male sex-typed professions: engineer, business manager, computer scientist, and physicist. One encompassed her answer, "Men? Men, I think they say that men can do anything." She added,

> Men? Men, I think they say that men can do anything. Occasionally, they would say, like, um, they would steer men away from doing something that more a girl would do, like, I don't see a lot of men hair stylists, but yet, some of the guys still want to do that as their occupation, and that's just, society is okay with that. Also, people would stereotypically think of singers as girls, but you see a lot of men singers. And, that's just because they had stepped out of society's comfort zone, and gotten the job they really felt like doing, and not just a job that was stereotypical and they wouldn't be happy doing, like a construction worker. I wouldn't want to be one of those.

Another girl chimed in with her response to what society felt it was okay for men to be in terms of professions,

> Yes, I do agree, I mean, men get most of the dirty work . . . they are the construction workers and they can be all these things, but they can be in a high position or a low position like you can be a construction worker for low pay or you can be like Barack Obama who is the president of the United States. Because there hasn't been a woman president yet, but Hilary Clinton has been trying for

> that. But, she has not succeeded in that yet, but she's close. I'd say actor, like, there are some really good men actors, but there are also directors, and all this, but I also think that society is use to more men lawyers and businessman and merchants and traders.

Another girl summarized,

> I think that like more society thinks of the common man working in buildings or heads of corporations. Like, the President of the United States. Like she said, like most presidents, tyrants, dictators, what have you.

An additional respondent answered,

> Men usually go for the mathematical things, and I'm not really sure why it's sort of like a stereotype, but I'd say either gender can do anything; it's just what's been out there in society.

What perceptions of STEM careers do middle school girls enrolled in a robotics curriculum have? When the researcher asked about middle school girls' perceptions about STEM careers, each group of girls asked that the researcher to repeat the question. The first group of girls did not feel comfortable answering, and so three out of the four girls passed. The second group of girls from Mrs. Alerton's class answered upon the researcher's clarification about what exactly the question was asking. The researcher explained that the purpose of the question was to discover perceptions that middle school girls or society had about STEM careers. Upon clarification in all groups (except the first group), the girls had an easier time answering the question. The first group of girls from Mr.

Gee's class talked extensively about their peers in other classes, and the second group of girls from Mr. Gee's class spoke about the perceptions that society might have about females or males in STEM fields (See Table 15).

Research Question 4

The researcher interviewed one male robotics teacher and one female robotics teacher to answer the fourth research question: "How do two teachers describe the performance of middle school girls participating in their robotics classrooms?" Both teachers answered six questions:

1. How do you feel about the participation of girls in the classroom?
2. How do you feel about the participation of boys in the classroom?
3. Do the girls participate more than the boys?
4. Do the boys participate more than the girls?
5. Are the girls as engaged as boys?
6. Are the boys as engaged as girls?

How Do You Feel About the Participation of Girls In the Classroom?

Both teachers felt that there was a good amount of participation from the girls. The male teacher said, two times, that the girls were more consistent with participation than the boys, and the female teacher answered that the level of participation was "good" (see Table 16). The female teacher added that it was likely that the level of participation was high because of the fact that she, herself, was female, and "as a woman," it was less intimidating for the girls to "speak up."

Table 15

What Perceptions of STEM Careers do Middle School Girls Enrolled in a Robotics Curriculum Have?
(Clarification Question: What Perceptions of STEM Careers do Middle School Girls or Society Have?)

Girl	Response
G1*	Well, I guess it's an opportunity to learn more about science, technology, engineering, and math, um, I've always felt that I was really good at math, and I really enjoy my science class, and VEX is a great opportunity to be exposed to that.
G2*	Pass
G3*	Pass
G4*	Pass
G5*	I think people want more, since its STEM, I think people expect men to do those professions because they think men are smarter and people are prejudiced to women doing those professions because of sexism (all laugh).
G6*	I think, many people, because of their gender, like, men do more of the math stuff, but my mom is actually really good at math so...
G7*	Men usually go for the mathematical things, and I'm not really sure why it's sort of like a stereotype, but I'd say either gender can do anything; it's just what's been out there in society.
G8*	I agree with [G5], [G7] and G6] that they [society] basically believe that the male should just do the STEM jobs, but I also feel like right now, there's a huge push for women to do those jobs.
G9	Well, um, I know that a lot of the girls in my grade, the occasional few, will say, Oh, yes, I want to do one of those STEM jobs, I want to be like a m teacher or an engineer or a s teacher, but so many of them say I want to be a singer, actor, or athlete.
G10	As I said before, they don't think about their future. I don't think they know what they want to do. So, I don't think they care...
G11	Well, I know, a lot of girls, but there are also others, I'm not personally a big fan of, like in science, they'll all just be talking and talking. And, I know my science teacher just hates our period because everyone is just constantly talking. Like the girls are always saying, "This is hard. I don't know what to do."
G12	I think, people usually they usually think some areas are hard than easy.
G13	For STEM, like, they think you have to be one of the top in your class. And, they think it's mostly men. Like women do nursing and teaching, and like, women can do STEM, but it's more men.
G14	People think that only men are STEM, but a lot of girls are more interested in it.

*Girl participant was in the female teacher's robotics classroom.

Table 16

How Do You Feel About the Participation of Girls in the Classroom?

Male Teacher's Descriptors	I think, overall, you get both ends of the spectrum with the girls. You got some like the boys who are completely engaged and leading the charge, and then you get some that every now and then want to sit back and be the worker bee, which is fine in certain circumstances. In the after school program that we are doing that you are watching the girls are more consistently participating in all aspects than the boys are in my opinion so I see a few more of the boys and part of that is that I didn't see/know the boys ahead of time and I didn't know the girls ahead of time; I had applications. I had a few of the boys who kind of want to just build their own thing and don't work as well with the groups; the girls honestly are better group workers than the boys consistently. But, like I said, some of the girls definitely are the leaders; some of the girls are great task-oriented kids.
Female Teacher's Descriptors	I feel like, at this age, I get a good level of participation. But, I feel like, as a woman, it's less intimidating for other girls to speak up.

How Do You Feel About the Participation of Boys in the Classroom?

Both teachers felt that, although boys "sometimes can overpower" or be "louder," the quality of participation between the boys and the girls was equal. The male teacher had several descriptors to support his answer regarding the participation of boys while the female teacher had none (See Table 17).

Table 17

How Do You Feel About the Participation of Boys in the Classroom?

Male Teacher's Descriptors	See, if I would've known that, I would have changed my answer. So, again, boys I think sometimes can overpower some of the girls in their opinions especially if they're really opinionated. I think in the after school program this year, it's really good. The boys are, for the most part, completely willing to listen to the girls, and I don't really have that. I've seen that happen before. Especially in the elective. I see a couple of girls who are very quiet, not pushy-to-the-front, out-front, kids, and they just sit back and they don't want to contribute ideas, they'll just sit back and go with whatever the boys say because in that class I have a lot of really power-boy kids, just they're, they're strong personalities that want to do specific things and they come up with these ideas, and I have two of my girls in that elective, will just kind of go with whatever the boys say, but then I have one girl who will sit there and say, 'No, that's not gonna to work. No, that's not gonna work. But, the boys in general, it seems, I have stronger personalities. As far as participation, I think they participate in the same level, like I said earlier, some of 'em I think I have a bigger spread on boys. I have some boys who are just don't-want-to-do-much-of-anything and then I have boys who are super crazy (pause) strong personalities and want to participate and do everything and that, they want, and sometimes it causes conflict with the boys because you get two of those kids in the same group and they're like, 'No, this is the way we are doing it. No, this is the way we are doing it.' They can't agree. I think the girls in general are better mediators of the conflict, that, than the boys are.
Female Teacher's Descriptors	I feel like at this age, boys are louder, but, I feel like, the quality of participation is equal between the boys and the girls.

Do the Girls Participate More Than the Boys?

When the researcher asked whether the girls participated more than the boys or vice versa, the male teacher paused, put his hand on his chin, grimaced, and struggled for the answer. At first, the male teacher felt that the participation of girls was "about the same level," but then, he changed his mind and he proceeded to say, "maybe slightly less." Then, he returned to the original remark, repeating, "It's probably about the same level." After he described girls as "some . . . who participate full steam ahead," he concluded that "girls are more consistent participators in their team." The female teacher answered with one sentence: "I think that it's pretty equitable, but I do think that boys are just louder at this age and make themselves heard."

Do the Boys Participate More Than the Girls?

When the researcher turned the question around and asked whether or not the boys participate more than the girls, the male teacher, at first, suggested that the boys and the girls are "pretty consistent." However, by the end of his answer, he did return to his original stance from the previous questions, and he did end, "the girls are more consistent." The female robotics teacher answered that the boys participate more than the girls, and she attributed this to the fact that "boys often take on more leadership roles."

Are the Girls as Engaged as the Boys?

When the researcher asked the male robotics teacher about the extent to which the engagement of girls was present, he proceeded to strongly agree with "Yes, absolutely." He agreed that the girls stayed engaged during the course of the robotics class. Even though he described the classroom as "definitely boy dominated," he felt that the girls had as much engagement in the classroom as the boys. The female robotics teacher did not feel that the girls were as engaged as the boys. She explained how "It's easier to get boys involved in robots" and getting girls interested in robotics is a struggle.

Are the Boys as Engaged as the Girls?

When the researcher asked about whether or not the boys were as engaged as the girls, the male robotics teacher affirmed, "Yeah, Definitely. The boys and girls, I think, are pretty close to engaged in terms of, they got the same amount of energy towards it. So, yes." The male robotics teacher saw an equal amount of engagement between the girls and the boys. The female robotics teacher felt that the boys were "very engaged in their roles," but this was not the case the previous year. The previous year, the female robotics teacher felt that "the girls were really resistant to take on some of those building and designing roles, and they were more engaged in the STEM project, the presentation, the research aspect of it."

Classroom Observations

Aside from the interviews and questionnaire, the researcher additionally wanted to assess both teachers' roles as classroom teachers, so she conducted a total of five classroom observations: three in Mr. Gee's classroom and two in Mrs. Alerton's classroom. Because Sadker and Sadker (1986) found that "teachers behaved differently depending on whether the student calling out [was] a boy or a girl," the researcher wanted to see, to what degree, a bias persisted in robotics classrooms. The researcher entered both classrooms eager to observe whether or not the male teacher or the female teacher had a bias towards females or males.

When the researcher entered the two classrooms, she found a stool in the back of the room. Both teachers did not introduce the researcher, and the researcher did not introduce herself, either. The researcher had a tally sheet in front of her, and she was ready to start tallying six different interactions and activities that might occur: students engaged in hands on activities, females or males initiating conversations, females or males raising their hands, females or males called upon by the teacher, female or male achievements acknowledged by the teacher, and sexist comments made by the male or female teacher.

Within the first five minutes of the classroom observations that took place in both the male and female teachers' classrooms, the researcher noticed a limitation. Both robotics classes did not lend to traditional interactions between teachers and students where students raised their hands and teachers responded to those requests. Both robotics classrooms started with students approaching prearranged group settings, prearranged team roles, and prearranged tasks that needed completion. Both robotics classrooms did not lend to teachers' acknowledging students loud enough for the researcher to hear all remarks. Hence, during all five observations, the researcher neither observed students raising their hands to ask the teacher for assistance nor observed the teacher acknowledging different students in a traditional classroom method. She was able to recognize a few achievements, however, noting Mr. Gee recognized one boy and one girl, and Mrs. Alerton recognized five females and two males. Over the course of the five classroom observations, the researcher did not observe the teachers or the students making sexist comments.

Chapter Summary

The researcher found that middle school girls participating in a robotics curriculum in the two California robotics classrooms described their experiences as personalized experiences that were positive and rewarding. Several girls responded to social and verbal persuasions when it came to their decisions to participate in a robotics curriculum, and several girls used mastery experiences to describe memories about the robotics curriculum.

The robotics curriculum supported real-life learning that was relevant to the girls' lives. Several girls considered robotics to be a curriculum that required learning through hard work and team participation. The girls found robotics to be a useful curriculum that allowed for the application of concepts that they learned in math and science classes.

The researcher discovered that several middle school girls have perceptions about STEM careers that are sex-typed, and several middle school girls are aware of societal constructs regarding the differences between jobs that are meant for men versus women. Some of the girls are aware of limitations that a girl's self-efficacy beliefs can have on future professional opportunities. One of the girls is aware of the societal belief that "Men? Men, I think they say that men can do anything."

Additionally, both robotics teachers had constructs and ideologies that delineated female roles from male roles, yet they did not exhibit these beliefs within and among the students in their classrooms. The researcher's interview questions gave each teacher an opportunity to express beliefs that they had about female roles versus male roles, and both teachers did express sexist ideologies that existed within their own personal constructs. But, both teachers taught the robotics class with an unbiased, objective approach where both boys and girls received an equal amount of attention, and the robotics curriculum seemed free of any inherent sexism.

CHAPTER 5

DISCUSSION

The problem this study sought to address is whether or not robotics could be a viable curriculum to interest middle school girls in science, technology, engineering, and math (STEM–related) fields. The review of the literature indicated that (1) girls struggled in STEM subjects more than did boys at multiple levels of their education, and the shortage of girls entering STEM-related fields was indisputable (Blickenstaff, 2005; Leaper et al., 2012; Milgram, 2011; Pettitt, 1995; Robelen, 2011; U.S. Department of Education, 1997b; Waters, 2011; Zeldin, et al., 2008); (2) classroom environments, including sexism in the classroom, impacted perceptions that girls were creating about STEM fields (Sadker & Sadker, 1994); and (3) educators started trying alternative curriculum like robotics to stimulate and keep girls interested in STEM-related fields (Barker & Ansorge, 2007; Chambers & Carbonaro, 2003; Mataric, 2004; Mauch, 2001; Palumbo & Palumbo,1993; Robinson, 2005; Williams et al., 2007). These findings helped frame the purpose for this study.

The purpose of this qualitative case study was to investigate the impact a robotics curriculum may have on the perceptions and experiences of middle school girls in two California classrooms. It also examined whether or not participation in a STEM-based, robotics curriculum could promote a classroom free of sexism where female participants could thrive.

The study addressed four research questions:

1. How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?
2. What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?
3. How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?
4. How do two teachers describe the performance of middle school girls participating in their robotics classroom?

The researcher conducted an embedded case study to investigate the impact a robotics curriculum could have on middle school girls' perceptions and experiences. The researcher collected data using interviews and classroom observations.

The researcher analyzed the data by placing the data into different categories, building tables with categories and evidence, and examining the data using Atlas Ti. The researcher triangulated the data for credibility and validity. What follows is a summary of major findings and interpretations with strengths and limitations as they relate to the conceptual and theoretical framework, implications, and recommendations for future research. The chapter closes with a summary of the dissertation.

Summary of Major Findings

The researcher presents a summary of major findings for each research question. For the first research question, the researcher describes findings related to middle school girls having positive experiences with robotics. For the second research question, the researcher explains how positive experiences with the robotics curriculum engendered personalized learning that involved meaningful, real world and relevant experiences. For the third research question, the researcher explains sex-typed career perceptions that middle school girls are aware of and have created, and, for the fourth research question, the researcher shows how two California robotics teachers are creating sexist-free robotics environments for the participants in their classrooms.

Research Question 1

The researcher sought to answer the question, "How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?" The researcher's findings were consistent with earlier research studies. In one earlier study, Bandura (1977) found that social and verbal persuasions enhanced self-efficacy beliefs, and when people observed others performing certain tasks, they classified the individual's performance as successful or not successful. As a result of these judgments from others, individuals felt that they were able to vicariously create their own personal models of capability and achievement. Additionally, when individuals experienced positive social and verbal persuasions from other individuals, they felt encouraged in the area in which they received the social or verbal persuasion.

Several girls from both classrooms described social and verbal persuasions that enhanced self-efficacy beliefs. Several girls described their robotics experiences as collaborative decision-making experiences between themselves and their family, friends, and teammates. Several of the girls mentioned parents, friends, and siblings that inspired them to "join the team." The researcher found that all participants talked about their initial experiences with robotics in a positive and quite favorable light, and their optimism seemed to stem from supportive verbal and social persuasions that came directly from their peers, siblings, teachers and parents.

The girls did not only mention the "social and verbal persuasions" that Bandura (1977) found as factors that enhanced self-efficacy, but the girls also mentioned the mastery experiences that Bandura discussed as well. Bandura (1977) argued that one's ability to perform, or experience, a phenomenon at a mastery level impacted their psychological stance, or position, about the phenomenon. Influenced by Bandura's (1977) work on self-efficacy and mastery experiences, Zeldin et al. (2008) investigated the narratives of 10 Caucasian males using a qualitative case study, and they found that men described mastery experiences as the most influential source for their personal self-efficacy beliefs in regards to STEM-related fields. They created strong self-efficacy beliefs about STEM-related fields when they had the ability to experience achievement within a STEM-related field. Usher and Pajares (2009) found a correlation between middle school students who had mastery experiences and middle school students who had strong mathematics self-efficacy beliefs and urged middle schools to consider perceived mastery experiences as powerful sources of students' mathematics self-efficacy beliefs.

The current study aligned with previous studies about mastery experiences. Ten out of 13 girls answered questions regarding memorable moments in robotics with a story about an accomplishment, or mastery, of some sort. Whether the mastery experience was one of Mrs. Alerton's girls who "got six balls in one bin at a time" or one of Mr. Gee's girls who "came out 17th out of 36," it was evident that most of the girls' memorable experiences involved an accomplishment of some sort. This alignment to several researchers' previous studies on mastery experiences contributed to interpretations that the researcher for this study would make in a later section of this chapter.

Furthermore, participants in both robotics classrooms discussed existential experiences with robotics that differed from traditional "guidance from the teacher" classroom lectures. Several girls felt that robotics was different than their math and science class because of the collaborative and communicative nature of the robotics classroom. One explained, "It's very social." Seven of the girls mentioned how students "do whatever you want" and work "on your own" instead of alongside a teacher's "guidance." Another girl added the detail, "we do most of the work on our own and find our own stuff; whereas, in classrooms, it's mostly presented to us." The participants' responses to the questions regarding similarities and differences within their science and math classrooms support the researcher's findings from Chapter 2 regarding robotics existing in a "direct manipulation environment" (Slangen, Van Keulen, & Gravemeijer, 2011).

Slangen, Van Keulen, & Gravemeijer (2011) explained how, unlike traditional curricula, robotics exists in a DME, where students are able to collaboratively design, creatively control, and imaginatively build solutions to prescribed outcomes. Several researchers discussed robotics as active, engaging, and collaborative (Barker & Ansorge, 2007, Mataric, 2004; Mauch, 2001; Palumbo & Palumbo, 1993). During the current study, several students alluded to this type of learning to describe how robotics is different from or similar to another class. One participant described, "we aren't doing any bookwork or lessons," and another participant described the personalized component where, "you have to design the robot yourself rather than have it presented to you." Seven girls mentioned the collaborative nature of the class, and how you have to "work together" to accomplish goals.

In conclusion, middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences as being personalized and very positive. Each girl's commitment to join robotics progressed from shared decision making involving family, friends, or their own personal decision, to memorable events that involved feelings of accomplishment and mastery. Additionally, all 14 middle school girls in the two California middle school classrooms described their participation in robotics as experiences that were collaborative and cooperative.

Research Question 2

The researcher sought to answer the research question, "What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?" The researcher's data aligned with the research findings. Chambers and Carbonaro (2003) explained that robotics allowed students "to creatively explore computer programming, mechanical design and constructing, problem solving, collaboration, physics, motion, music—all within an active, enjoyable, and nonthreatening setting" (p. 209). The researcher found that the girls in the two middle school robotics classrooms learned not only that robotics was a curriculum that was active, engaging, and collaborative but also that robots were real-world applicable devices that added relevancy to their learning.

The researcher found that the middle school robotics curriculum in both classrooms supported not only what the research stated about the effectiveness of robotics in the classroom but also real life learning that became applicable and relevant to the girls' lives. Eleven of the 14 girls described robots as machines, or systems, that supported a human's limitations. They described robots as helpers for "specific jobs" to "help humans do things." Some of the girls mentioned how robots are like computers, iPads, iPhones, and calculators that support our human existence. Several of the girls mentioned how robots support our military needs, medicinal fields, and transportation sectors. The girls discussed how robots "make things easier, much easier," and "for like productivity," robots can assist. The girls discussed the robot's abilities to "entertain people" and "navigate" for humans. Most of the girls mentioned real world applications that paralleled the robotics curriculum. In conclusion, middle school girls participating in a robotics curriculum in two California middle school classrooms learned about real-world applicable devices that add relevancy to personalized learning.

Research Question 3

The third research question sought to address "How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?" The researcher's findings show that middle school girls who are participating in a robotics classroom in two different California classrooms have career aspirations that extend and challenge current societal beliefs. Several girls discussed limitations that society sets in regard to their beliefs about men versus women and about each gender's capabilities to achieve mastery in certain occupations. Generally, the girls felt confident about their abilities to do well in STEM fields, but the girls' responses were not overwhelmingly positive and confident.

Pettitt's (1995) study showed that students sex-typed career aspirations, and several STEM careers did not fall under the female sex-typed career category. Pettitt found that girls sex-typed careers even though they felt that society accepted both men and women in certain STEM-related fields. Especially when it came to science-related jobs, girls did not see themselves as having the necessary skills to succeed. For the current study, the researcher discovered that the middle school girls in the two different robotics classrooms also sex-typed certain STEM fields as male-dominated fields and certain other fields as female-dominated fields. The questionnaire that the girls filled out showed that the "doctor" and "mathematician" received the most "his" responses from the girls with 10 girls perceiving doctors and mathematicians to be men. The "surgeon" received the next most "his" responses with nine responses from the girls. The "scientist" received seven "his" pronouns. The "teacher" and the "singer" professions both received zero "his" pronouns and all "her" pronouns, as all 14 girls perceived these two professions as professions held by females.

Furthermore, the girls explained how society sex-typed jobs, and one particular participant expressed the perception that existed about men: "Men? Men, I think they say that men can do anything." Several girls mentioned the existence of sexism in society's beliefs about STEM careers and the men who fill STEM-related jobs. However, several of the girls seemed to know about society's beliefs, the limitations they would face as girls and women, and how they might need to challenge the status quo.

When the researcher asked the girls about professions that they would "really like to be" or "kind of like to be," more than half of the girls chose a STEM-related field as a profession that they would "really like to be" and most of the girls chose a STEM-related field as a profession that they would "kind of like to be." Additionally, the researcher's findings suggest that several of the girl participants did not feel that they had the skills, or abilities, to be successful at the professions they chose—several being STEM-related professions. Most of the girls saw the professions as jobs that required hard work and more learning.

One of Mrs. Alerton's and one of Mr. Gee's students answered confidently that they definitely had the skills or could gain the skills to be successful at the professions they chose. In conclusion, middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers as sex-typed where certain jobs are more applicable to men and other jobs are more applicable to women, and they also perceive STEM careers as challenging and hard.

Research Question 4

The researcher interviewed Mrs. Alerton, the female robotics teacher, and Mr. Gee, the male robotics teacher, to answer research question 4: "How do two teachers describe the performance of middle school girls participating in their robotics classroom?" During the classroom observations, the researcher did not hear any sexist language between students and their peer groups or students and teachers, and the researcher did not see any substantial tallies that indicated a sexist classroom. But, the researcher did hear sexist constructs and ideologies during each robotics teacher's private interview. These sexist ideologies did not surface inside either robotics classroom.

Both teachers referred to sexist ideologies and gender structures during the interview conducted by the researcher, but none of the biases surfaced in their classrooms. When the researcher asked the first of four questions about the participation of the girls, Mr. Gee responded, "You got some [girls] like the boys who are completely engaged and leading the charge, and then you get some that every now and then who want to sit back and be the worker bee, which is fine in certain circumstances." Mrs. Alerton answered the same question, "I feel like, at this age, I get a good level of participation. But, I feel like, as a woman, it's less intimidating for other girls to speak up." Both teachers made assumptions about the girls' and boys' gender roles and their levels of engagement based upon gender. Mr. Gee felt that the girls were participating "like the boys" instead of resorting to the usual "worker bee" status, and Mrs. Alerton felt that the girls were only participating more because of the girls' ability to identify with her "as a woman."

When the researcher asked both teachers the second question, which was the same as the first question, except this time, the researcher asked about the participation of "boys" instead of the participation of "girls," again, both teachers shared constructs that sounded sexist. Mr. Gee referred to boys as those who "can overpower some of the girls" and their "power-boy" behaviors and "strong personalities" or "super crazy strong personalities" can end up causing conflict. Mr. Gee classified the girls as "better mediators" of the conflict. Mrs. Alerton asserted, "Boys are louder." These findings suggest that the robotics teachers are describing the performance of girls using a sexist lens.

Then, when the researcher asked both teachers whether the girls participate more than the boys or vice versa, the male teacher expressed that "the girls are more consistent" than the boys, and the female robotics teacher answered with a sexist remark about the boys participating more than the girls because "boys often take on more leadership roles." When the researcher asked both teachers about boys' and girls' engagement in the class, both teachers had sexist language within their answers. Mr. Gee mentioned a "boy dominated" room and Mrs. Alerton stated, "It's easier to get boys involved in robots" whereas the girls wanted to engage in the "STEM project, the presentation, [and] the research aspect of it." In conclusion, these findings helped answer the researcher's question about how teachers are describing the performance of middle school girls, and the findings suggest that both middle school robotics teachers are describing girls using sexist constructs that show a bias against girls and their abilities to succeed in a robotics classroom. Regardless, both middle school robotics teachers are creating a sexist-free environment for girls participating in a robotics curriculum.

Interpretations

From the findings, the researcher was able to conclude that a robotics curriculum can be a viable curriculum to sustain, support, and potentially salvage a girl's perceptions about STEM-related fields. Although this study was limited to two California robotics classrooms, the findings support research that showed how a robotics curriculum may create real-life, relevant learning experiences that are rewarding for girls (Barker & Ansorge, 2007; Chambers & Carbonaro, 2003; Mataric, 2004; Mauch, 2001; Palumbo & Palumbo,1993; Robinson, 2005; Williams et al., 2007).

This study's findings align with Zeldin et al.'s (2008) study regarding positive messages and models proving influential during female participants' pursuit of STEM careers. The current study showed middle school girls experiencing robotics in a personalized, positive, and rewarding way even though societal stereotypes about a woman's role in STEM fields existed. The interviews proved that the robotics curriculum supported real-life learning that was relevant to the girls' lives, and the girls found robotics to be a useful curriculum that allowed for the application of concepts that they learned in other classes, including math and science. These positive and applicable experiences transformed their learning, and it gave girls an opportunity to perceive and experience what one might accomplish in a STEM-related profession. The girls had perceptions about STEM-related fields, and they seemed to know about societal perceptions about STEM-related fields. Robotics provided them with an avenue to explore and familiarize themselves with STEM-related fields.

A limitation that the study presented was when the researcher asked about the several different career choices. The research design lacked anonymity. With anonymity, the girls may have answered the questions about the professions differently. It is uncertain whether or not the girls felt pressured to choose certain careers over other careers based on inherent societal stereotypes and whether or not the girls answered the questions about careers with hesitation because of the homogenous peer group setting and the researcher's gender.

This study also shed light on how a classroom environment can change with alternative curricula. It became evident that the curriculum, robotics, could add to the classroom's transformative and reformative teaching environment. Sadker and Sadker (1994) noticed sexist classroom settings that sometimes involved teachers, textbooks, and curriculum. Girls' perceptions about STEM-related fields changed as classroom settings became more sexist.

During the interviews, both robotics teachers mentioned sexist constructs and ideologies that were oppressive to girls and women, but during both teachers' robotics classes, these sexist beliefs did not infect the classroom. Both teachers showed an equal and impartial amount of attention towards the girls and the boys, and both teachers exuded an unbiased objectivity free of sexism.

The robotics curriculum substantiated a rich, fast-paced environment that kept sexist constructs and ideologies out of sight. Robinson (2005) explained that the robotics curriculum is a very different tool from the traditional computers and textbooks that classrooms usually use. In contrast to traditional classrooms where students are seated in rows and textbooks are open to a particular page with a teacher at center stage, today's robotics classroom entails a great deal of personalization. Teachers are aware of each student's interest, knowing what to deliver next. In addition, students are the chief engineers in the room. Each child engineers her own curriculum, deciding whether she will build, program, create, write, or research as her next step.

Because both robotics classrooms did not follow traditional classroom models with the teacher at center stage, the researcher faced limitations with her Classroom Tally Sheet. Traditional interactions between teachers and students did not take place. The number of times a student engaged in hands-on activities was numerically inexpressible. It was impossible to count the number of times a female student spoke or a male student spoke because all of the students spoke frequently. Students did not raise their hands, and teachers did not call on students. Both robotics classrooms did not lend to whole class lectures where the researcher could hear the teachers' remarks. Given these limitations, the researcher tallied as much as she could, but at the end of it all, the subjectivity that was engendered by the researcher's role became very evident.

Peshkin (1988) warned about the researcher's role and how difficult it is to "escape the thwarting biases that subjectivity engenders, while [at the same time] attaining the singular perspective its special persuasions promise" (p. 21). At the outset, the researcher grasped this warning as a caution against biases toward the robotics curriculum and the critical feminist lens. But, at the end, it became clear that the special promises that Peshkin (1988) warned about became the effective pedagogical approaches by both the female and male robotics teachers, and the engendered subjectivity became the realization that the researcher's own role as a classroom teacher in a more traditional classroom setting actually limited the study's capacity.

The robotics curriculum contributed to the middle school girls' awareness that "Girls? Girls can do anything!" None of the girls blatantly made this statement, but it was evident in both robotics classrooms that the girls and the boys inherently had one task: work cooperatively, collaboratively, and ultimately, in an environment that is free of sexism. Both classrooms were set up in such a way that the teacher/student dynamics alongside student/student dynamics supported the middle school girls' self-efficacy beliefs, especially in the area of STEM-related fields. The robotics curriculum created a conducive environment that engendered rich and rewarding experiences. The curriculum set a stage that proved liberating to girls and worthwhile to any teacher trying to create a STEM-based setting.

The research for the dissertation was grounded in the literature on critical feminist theory, which emphasizes the liberation of individuals, specifically females, from oppressive political and cultural conditions like sexism (Noddings, 2012). The researcher's discoveries prove that oppressive political and cultural conditions like sexism not only infect the minds of classroom teachers but also plague the minds of middle school girls. Both teachers expressed a number of gender biases they considered as factors to explain the participating and engagement of girls and boys. Several of the girls expressed their awareness of stereotypes and biases and several expressed the importance of liberating themselves from the oppressive biases and stereotypes. Sexism exists in the minds of middle school girls, and the statement "Girls? Girls can do anything," did not exist in the hearts of the girls who participated in the study.

Implications

The study has implications for policy makers, practitioners, and theorists. For policy makers, the study might give insight into the shortage of girls in STEM-related fields and the importance of focusing on sustaining interest and participation. For practitioners, the study might give insight into alternative curricula like robotics and its ability to create direct manipulation environments that create meaningful, real-life and relevant learning opportunities free of sexist curriculum. Finally, the study might give insight to theorists who seek to liberate girls and females from oppressive political and cultural conditions like sexism.

Implications for Policy

A range of research showed that girls struggled in STEM subjects more than boys at multiple levels of their education, and the shortage of girls entering STEM-related fields was indisputable (Blickenstaff, 2005; Leaper et al., 2012; Milgram, 2011; Pettitt, 1995; Robelen, 2011; U.S. Department of Education, 1997a; Waters, 2011; Zeldin et al., 2008). Previous research aligns with the study's current findings in that, as early as middle school, girls are aware of perceptions that society creates regarding female and male roles in STEM-related fields. In order to increase the number of girls entering STEM-related fields, policy makers can first consider starting robotics programs at a much earlier age, potentially sustaining and salvaging a girl's interest and motivation to participate and stay in a STEM-related field. Second, policy makers might consider mandates requiring STEM-based classrooms, curricula, or textbooks to operate under periodical audits, ensuring the teaching environment promotes hands-on activities that are collaborative and free of gender biases, materials are gender neutral or are equally representative of both female and male role models, and STEM classroom teachers are equally represented by both female and male teachers. Third, policy makers should consider requirements for teachers. Teachers should have mandatory periodical staff developments that provide time for teachers to reflect and inquire about gender biases that they allow or can potentially engender in their classrooms.

Implications for Practice

Jonassen et al. (1999) explained that the robotics curricula functioned as a mindtool where participants took active roles (researching, programming, and building) in the learning process. Mauch (2001) found that the LEGO NXT robots "show[ed] promise in helping students not only with direct, hands-on problem solving, but with written problem solving as well" (p. 211). Mataric (2004) called for the consideration of robotics, as an alternative curriculum, at all educational levels. For future practitioners, the current study supports the need for STEM-based classroom environments that are more collaborative and cooperative, increasing the chances that girls will stay interested in STEM-related fields. Additionally, the current study supports the need to start STEM-based curricula like robotics earlier than middle school, increasing the amount of time that girls can be engaged in hands-on, collaborative, and cooperative activities that can build positive, self-efficacy beliefs toward STEM-related fields.

Implications for Theory

Noddings (2012) emphasized the liberation of individuals, specifically females, from oppressive, political and cultural conditions like sexism. For theorists, this study confirms that gender constructs continue to exist. Researchers need to continue to examine the effects that biased ideologies from society, students, and educators can have on female and male students. Critical feminist theorists should continue to safeguard students by working individually and collaboratively toward more equal access. Whether through policy work, research, or practice, critical feminist theorists need to keep the conversation about gender discrimination, gender inequalities, and gender biases active.

Implications for Future Research

Some researchers may see the work of a critical feminist theorist as an area of work that is of the past and not of the future. In addition, one might even question why a researcher would give credit to a 30-year-old study on gender biases. Thirty years ago, Sadker and Sadker (1986) challenged educators to actively work against biases in the classroom so that achievement would not be inhibited. Twenty years ago, Pettitt (1995) observed, "There is still much work to be done to support girls' pursuit of non-traditional career options" (p. 7). Ten years ago, Zeldin, Britner, and Pajares (2008) documented information about women recalling negative social messages and models even though experiences with positive messages and models proved more influential than the negative messages in their pursuit of STEM careers. The need for researchers to continue the critical discourse on best practices for middle school girls—especially in the areas of science, technology, engineering, and mathematics (STEM)—is critical.

It becomes imperative for researchers to conduct future research in the area of girls' interests in STEM-related fields. The current study focused on two California middle school robotics classrooms, but future studies may expand beyond the walls of these two robotics classrooms. Future studies might consider a much larger sample size that reaches across the country in different towns, counties, and cities. Additionally, future studies might include homogenous and heterogenous groups with boys and girls answering questions and questionnaires about robotics and STEM professions. Future research may also examine perceptions and the self-efficacy of younger students engaged in a robotics or similar curriculum and how they may affect their interest in STEM-related fields over time.

Future research needs to examine whether or not all girls are receiving equal access to STEM-based classrooms that encourage hands-on, cooperative and collaborative learning alongside teachers who are encouraging STEM. Researchers might enter into different STEM-based classrooms across the country, in socioeconomically advantaged and disadvantaged neighborhoods and racially diverse and racially uniform neighborhoods, to investigate decisions that not only the districts but also the teachers are making regarding accessibility to STEM. These researchers would also have to observe the curricula's objectivity and whether or not districts and teachers are introducing the curriculum in a way that is unbiased and free of sexism.

One other area that needs future research includes observations in both traditional science and math classrooms and STEM-based classrooms that are not traditional. Researchers might inquire about the similarities and differences between STEM-based classrooms and traditional classrooms. Researchers might question whether or not teachers are introducing the curriculum in these two different classroom settings in a way that is hands-on, collaborative, cooperative, relevant and real-life or more traditional with the teacher at center stage.

Recommendations

The researcher offers six recommendations for addressing the shortage of girls in STEM-related fields. These six recommendations involve the accessibility of STEM-related curricula to adolescent girls, the support of STEM-based curricula and STEM-related career options to adolescent girls, and the sustainability of teachers creating rich, STEM-based learning environments for adolescent girls.

STEM For K-12 Girls

Margolis and Fisher (2002) confirmed that adolescent girls developed negative perceptions about STEM fields as they grew into their identities. By the eighth grade, girls who once thought they were good at math and science no longer felt that that was the case. The current study showed that girls had developed negative perceptions about STEM fields by the time they reached middle school. The researcher has two recommendations for educational leaders hoping to enact change in the area of the shortage of girls in STEM related fields:

1. Educational leaders need to prioritize directives from the nation's Department of Education and the California Department of Education on K-12 STEM curriculum and statistical data on STEM-related careers and girls entering into these fields. For example, STEM coordinators need to allocate sufficient funds for STEM, create districtwide STEM mission statements that delineate how they will support girls specifically, provide teachers with STEM

resources, and support STEM activities, projects, and curriculum in the classroom.

2. Educational leaders need to introduce, promote, and support K-12 STEM-based career options to girls in the primary and elementary grades. Educational leaders can do this by providing cooperative and collaborative opportunities for girls to engage in STEM activities and learn about STEM-based professions. During classroom time, real-life and relevant examples of women in STEM careers would help and, alongside this, community partnerships and quarterly STEM-based field trips might help.

Robotics

Mataric (2004) called for the consideration of robotics as an alternative curriculum at all educational levels. The current study showed that a robotics curriculum was able to interest girls through personalized learning opportunities that were very hands-on, collaborative, and cooperative. Alongside these qualities, the robotics curriculum offered real-life learning that had relevancy to the girls' lives. The researcher has two recommendations:

1. Educational leaders need to experiment with the robotics curriculum, providing schools with robotics resources, teachers with staff development, and students with up-to-date and state-of-the-art equipment.

2. Educational leaders need to introduce the robotics curriculum and different programming platforms in the primary and elementary

grade levels. This may prevent girls from developing negative perceptions about STEM fields as they grow into their identities.

Learning Environments

Researchers found that sexism was inherent in teachers' lessons, publishers' textbooks, and classroom learning environments. These sexist situations were found to have an impact on female self-efficacy beliefs and perceptions about STEM-related fields. This research study found that the robotics classroom environment supported a classroom free of sexist attitudes and beliefs, and the sexist-free environment promoted strong self-efficacy beliefs that the girls held. The researcher has two recommendations in this area:

1. Educational leaders should consider new policies that require classroom teachers to have professional development training pertaining to creating classroom environments that allow pre-adolescent and adolescent girls to thrive.
2. Educational leaders should consider new policies that require districts to have STEM program coordinators and schools to have STEM site coordinators who promote STEM learning environments that are rich and rewarding, especially for girls.

Summary of Dissertation

The dissertation began with the background of the problem, which was divided into three sections: (1) the history of science, technology, engineering, and mathematics and its current impact at the local educational level; (2) the data that indicate how our nation struggles in STEM and, more specifically, how our country faces an underrepresentation of females in STEM-related fields; and (3) robotics as one viable curriculum that educators are using to keep girls interested in STEM-related fields. Following the background of the problem, the researcher identified the problem of whether or not robotics was a viable curriculum to interest middle school females in STEM-related fields. The purpose of this study was to investigate the impact a robotics curriculum might have on the experiences and perceptions of middle school girls in two California classrooms. Chapter 1 ended with the four research questions:

1. How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?
2. What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?
3. How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?
4. How do two teachers describe the performance of middle school girls participating in their robotics classroom?

In Chapter 2, the researcher introduced the theoretical framework, critical feminist theory, and three conceptual frameworks: self-efficacy beliefs, the sexist classroom, and robotics. The researcher introduced the research that had already been done on adolescent girls and the perceptions that they held about STEM career options, self-efficacy beliefs that they created about themselves and their abilities to enter into STEM professions, the sexist classroom, and robotics as an alternative curriculum. The body of literature on robotics, an alternative curriculum that educational leaders had experimented with, to sustain, support, and potentially salvage a girl's perceptions about STEM related fields concluded Chapter 2.

In Chapter 3, the researcher presented the methodology as an embedded case study. The researcher introduced the Southern California district, the two California classrooms, the two teachers, the participants and the researcher. The researcher concluded the chapter with specification regarding her two instruments (interviews and classroom observations) and data collection procedures involving Atlas Ti.

In Chapter 4, the researcher presented her findings, creating tables to categorize the information that she retrieved through the robotics classroom observations and the interviews. The researcher organized the chapter by the study's research questions.

In Chapter 5, the researcher discussed the major findings of the study, addressing each research question. First, she explained the positive and rewarding experiences that the middle school girls had in each of the two California middle school robotics classrooms; second, she explained the collaborative and cooperative classroom environment that the robotics curriculum provided to the middle school girls; third, she explained that middle school girls had perceptions about STEM-related careers that were sex-typed; and, fourth, she explained that the two robotics teachers were able to create sexist-free classroom environments even though several of the students had preconceived ideas about the roles of men and the roles of women in certain professions. The researcher provides her interpretation and the implications of the findings, and presents several recommendations for addressing the shortage of girls in STEM related fields.

In conclusion, the researcher's findings suggest that a robotics curriculum can be a viable curriculum to interest middle school girls in STEM-related fields. Furthermore, the researcher provides several recommendations, including the suggestion that schools offer robotics or a form of robotics at the primary and elementary levels to help girls develop positive perceptions about STEM fields as they grow into their identities.

REFERENCES

Agee, J. (2009). Developing qualitative research questions: A reflective process. *International Journal of Qualitative Studies in Education, 22*(4), 431-447.

American Association of University Women (1995). *How schools shortchange girls: The AAUW report: A study of major findings on girls and education.* New York, NY: Marlowe & Company.

American Association of University Women (2000), *Shortchanging girls/shortchanging America*. Greenberg-Lake: The Analysis Group. Retrieved from http://www.aauw.org/files/2013/02/shortchanging-girls-shortchanging-america-executive-summary.pdf

Anderson, D. L. (2005). A portrait of a feminist mathematics classroom: What adolescent girls say about mathematics, themselves, and their experiences in a "unique" learning environment. *Feminist Teacher, 15*(3), 175-194.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215. Retrieved from http://www.uky.edu/~eushe2/Bandura/Bandura1977PR.pdf

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71-81). New York, NY: Academic Press. (Reprinted in H. Friedman [Ed.], *Encyclopedia of mental health.* San

Diego, CA: Academic Press, 1998). Retrieved from http://www.uky.edu/~eushe2/Bandura/BanEncy.html

Barker, B. S., & Ansorge, J. (2007). Robotics as means to increase achievement scores in an informal learning environment. *Journal of Research on Technology, 39*(3), 229-243.

Blickenstaff, J. C. (2005) Women and science careers: Leaky pipeline or gender filter? *Gender and Education, 17*(4), 369-386. doi: 10.1080/09540250500145072

Brown, S. W. (2002) Hispanic students majoring in science or engineering: What happened in their educational journeys. *Journal of Women and Minorities in Science and Engineering, 8*(2), 123-148.

Bryant, S. D. (2011). *It's nothing personal: Competing discourses for girls and women in mathematics* (Doctoral dissertation). Retrieved from Open Access Dissertations. AAI3461992

California Department of Education. (2013). *Science, technology, engineering, & mathematics.* Retrieved from http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp

Carlone, H. B. (2004). The cultural production of science in reform-based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching*, *41*, 392-414.

Carnevale, A. P., Smith, N., & Melton, M. (n.d.) *STEM: Executive summary. Center on Education and the Workforce*. Retrieved from Georgetown

University website: http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stem-execsum.pdf

Chambers, D., & Carbonaro, M. (2003). Designing, developing, and implementing a course on LEGO robotics for technology teacher education. *Journal of Technology and Teacher Education, 11*(2). 232-241.

College Board, Program Summary Report. (2011). *National and statewide AP Program data at a glance.* Retrieved from http://media.collegeboard.com/digitalServices/pdf/research/AP-Program-Summary-Report-2011.pdf

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches.* Los Angeles: SAGE.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches.* Los Angeles, CA: Sage Publications, Inc.

Creswell, J., & Plano Clark, V. (2011). *Designing and conducting mixed methods research.* Thousand Oaks, CA: Sage Publications.

Eccles, J.S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flannagan, C., & Mac Iver, D. (1993) Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and in families. *American Psychologist, 48*(2), 90-101.

Engineering Workforce Commission. (2011). *Engineering and technology degrees, 2010,* Table 5-13. Washington, DC: Author.

Farland-Smith, D. (2009). Exploring middle school girls' science identities: Examining attitudes and perceptions of scientists when working "side-by-side" with scientists. *School Science and Mathematics*, *109*(7), 415-427.

Glatthorn, A. A., Boschee, F. A., Whitehead, B. M., & Boschee, B. F. (2012). *Curriculum leadership: Strategies for development and implementation.* Thousand Oaks, CA: Sage Publications.

Goals 2000. (1994) Educate America Act, H.R. 1804. Retrieved from http://thomas.loc.gov/cgi-bin/bdquery/z?d103:H.R.1804:

Hall, R. M., & Sandler, B. R. (1982). The classroom climate: A chilly one for women. Washington, DC: Project on the Status of Education of Women, Association of American Colleges. Retrieved from http://www.aacu.org/psew/publications/Classroom_Climate_ChilyOne.pdf

Haller, E. J., & Kleine, P. F. (2001). *Using educational research: A school administrator's guide*. New York, NY: Longman.

Halpern, D., Aronson, J., Reimer, N., Simpkins, S., Star, J., & Wentzel, K. (2007). *Encouraging girls in math and science* (NCER 2007-2003). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ncer.ed.gov

Hyde, J. S. (2005). The gender similarities hypothesis. *American Psychologist, 60*(6). 581-592. doi: 10.1037/0003-066X.60.6.581

International Test and Evaluation Association. (2009). The overlooked STEM imperatives: Technology and engineering K-12 education. Retrieved from http://www.nbtschools.org/nbts/Schools/Linwood%20Middle%20School/Curriculum%20Resources/Announcements/Technology%20Education/STEM%20%26%20Technology%20Resources/Teachers%20Resources/STEM%20Resources/STEM%20Guide.pdf

Jonassen, D. H. (1984). *Computers in the classroom: Mindtools for critical thinking.* Upper Saddle River, NJ: Prentice Hall.

Jonassen, D. H., & Peck, K.L., and Wilson, B.G. (1999). *Learning with technology: A constructivist perspective.* Upper Saddle River, NJ: Prentice-Hall.

Leaper, C., Farkas, T., & Brown, C. S. (2012). Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and English. *Journal of Youth Adolescence, 41*, 268-282. doi: 10.1007/s10964-011

Maras & Archer, (1997). 'Tracy's in the home corner, Darren's playing Lego, or are they?' *Feminism Psychology, 7*(2). doi: 10.1177/0959353597072011 264-274

Margolis, J., & Fisher, A. (2002). *Unlocking the clubhouse: Women in computing* [Google eBook version]. Retrieved from http://books.google.com/books?hl-=en&lr=&id=StwGQw45YoEC&oi=fnd&pg=PR7&dq=Unlocking+the+Club-+house:+Women+in+Computing&ots=nmJ1NV90qL&sig=ev8pGIrkW9o56ppi-A_1a_osf3s#v=onepage&q=Unlocking%20the%20Club-%20house%3A%20Women%20in%20Computing&f=false

Martin, F., Mikhak, B., Resnick, M., Silverman, B., & Berg, R. (2000). To Mindstorms and beyond: Evolution of a construction kit for magical machines. In J. Hendler, & A. Druin (Eds.), *Robots for kids*. Retrieved from http://www.cs.uml.edu/~fredm/papers/magical-machines.pdf

Mataric, M. J. (2004, March). *Robotics education for all ages*. Proceedings presented at AAAI Spring Symposium on Accessible, Hands-on AI and Robotics Education, Palo Alto, CA. Retrieved from http://robotics.usc.edu/~maja/publications/aaaissymp04-edu.pdf

Mauch, E. (2001). Using technological innovation to improve the problem-solving skills of middle school students: Educators' experiences with the LEGO Mindstorms robotic invention system. *Using Technological Innovation, 74*(4), 211-213. Retrieved from http://home.wlu.edu/~kuehnerj/cv/clearinghouse_2001.pdf

McDonald, S., & Howell, J. (2012) Watching, creating and achieving: Creative technologies as a conduit for learning in the early years. *British Journal of Educational Technology*, *43*(4). doi: 10.1111/j.1467-8535.2011.01231.x 641-651

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Milgram, D. (2010, June). *CalWomenTech project: Recruiting and retaining women in technology programs*. Paper presented at the meeting of the American Society for Engineering Education, Louisville, KY.

Milgram, D. (2011, November). How to recruit women and girls to the science, technology, engineering, and math (STEM) classroom. *Technology and Engineering Teacher*, 4-11. Retrieved from http://www.wtea-wis.org/wordpress/?wpfb_dl=447

National Academies of Science. (2005). *Rising above the gathering storm, revisited.* Washington, DC.: The National Academies Press. Retrieved from http://www.uic.edu/home/Chancellor/risingabove.pdf

National Research Council. (1996). *National science education standards.* Washington, DC: Academic Press.

National Research Council. (2007) *Rising above the gathering storm: Energizing and employing America for a brighter economic future.* Washington, DC: The National Academies Press.

National Science Foundation. (2007). *Back to school: Five myths about girls and science.* Division of Science Resources Statistics. Retrieved from http://www.nsf.gov/news/news_summ.jsp?cntn_id=109939

National Science Foundation. (2011). *Women, minorities, and persons with disabilities in science and engineering.* Division of Science Resources Statistics. Retrieved from: http://www.iguana-robotics.com/publications/Robots%20for%20Science%20EducationWhite%20paper.pdf

National Science Teachers Association (NSTA). (2003). *Standards for science teacher preparation:* Retrieved from http://www.nsta.org/pdsf/nstastandards2003.pdf

Noddings, N. (2012). *Philosophy of education*: (2nd ed.). Boulder, CO: Westview Press.

Notter, K. B. (2010) *Is competition making a comeback? Discovering methods to keep female adolescents engaged in STEM: A phenomenological approach* (Doctoral dissertation). Retrieved from http://digitalcommons.unl.edu/cehsdiss/79

Nourbakhsh, I. R., Crowley, K., Bhave, A., Hamner, E., Hsiu, T., Perez-Berquist, A., . . . Wilkinson, K. (2005, January) The robotic autonomy mobile robotics course: Robot design, curriculum design and educational assessment. *Autonomous Robots*, *18*(1). 103-127.

Nugent, G., Barker, B., Grandgenett, N., & Adamchuk,V. (2010). Impact of robotics and geospatial technology interventions on youth STEM learning and attitudes. *Journal of Research on Technology in Education*, *42*(4), 391-408.

Ontiveros, C., & Alvarez, E. (2012). *Inspiring and engaging the next generation in STEM through PLTW and REAL.* Paper presented at the 2012 ASQ Advancing the STEM Agenda in Education, the Workplace and Society Conference, Menomonie, WI.

Palumbo, D., & Palumbo, D. B. (1993). A comparison of the effects of Lego TC Logo and problem solving software on elementary students' problem solving skills. *Journal of Computing in Childhood Education, 4*(3-4), 307-323.

Papert (1980) *Mindstorms: Children, computers, and powerful ideas.* New York, NY: Basic Books. Retrieved from http://dl.acm.org/citation.cfm?id=1095592

Peshkin, A. (1988). In search of subjectivity: One's own. *Educational Researcher, 17*(7), 17-21.

Pettitt, L. M. (1995, March-April) *Middle school students' perception of math and science abilities and related careers.* Paper presented at the 61st Biennial Meeting of the Society for Research i*n Child Development*, Indianapolis, IN.

Pettitt, L. M., & Patrick, J. A., & Sternitzke, M. E. (1995). *Middle school students' perceptions of math and science abilities and related careers.* Bethesda, MD: National Institute of Child Health and Human Development (NIH). 2-20. ED380663

Pezalla-Granlund, N. (2005) *Rethinking robotics: Learning through creative engineering.* Paper presented at the ASTC Conference Playful Invention & Exploration. Retrieved from http://llk.media.mit.edu/papers/Rethinking-Robotics-v2.pdf

Philbin, M., Meier, E., Huffman, S., & Boverie, P. (1995). A survey of gender and learning styles. *Sex Roles, 32*(7-8), 485-494. Retrieved from http://download.springer.com/static/pdf/821/art%253A10.1007%252FBF01544184.pdf?auth66=1392691379_70a59a517e59ed34065e72bfd609147f&ext=.pdf

Potter, E. F., & Rosser, S. V. (1992), Factors in life science textbooks that may deter girls' interest in science: *Journal of Research in Science Teaching, 29,* 669-686.

President's Council of Advisors on Science and Technology. (2010). *Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future* (Prepublication version). Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

Rogers, C., & Portsmore, M. (2004). Bringing engineering to elementary school. *Journal of STEM Education: Innovations & Research*, *5*(3-4), 17-28.

Robelen, Erik. (2011, December 15). White House issues inventory of STEM education spending [Web blog post]. Retrieved from http://blogs.edweek.org/edweek/curriculum/2011/12/amid_all_the_talk_about.html

Robinson, M. (2005). Robotics-driven activities: Can they improve middle school science learning? *Bulletin of Science, Technology & Society, 25*(1), 73-84. doi: 10.1177/0270467604271244

Sadker, M., & Sadker, D. (1986). *Sexism in the classroom: From grade school to graduate school. 67*(7), 512-515.

Sadker, M., & Sadker, D. (1992). Ensuring equitable participation in college classes. *New Directions for Teaching and Learning*, *49,* 49-56.

Sadker, D., & Sadker, M. (1994). *Failing at fairness: How America's schools cheat girls*. New York, NY: Charles Scribner's Sons.

Sadker, D., & Silber, E. S. (2007). *Gender in the classroom: Foundations, skills, methods, and strategies across the curriculum.* Mahwah, NJ: Lawrence Erlbaum Associates.

Sadker, D., & Zittleman, K. (2005). Gender bias lives, for both sexes. *The Education Digest*, *70*(8), 27-30.

Sanders, Mark (2009). STEM, STEM education, STEMania. *The Technology Teacher. 68*(4), 20-26.

Seaton, E. E. (2007). If teachers are good to you: Caring for rural girls in the classroom. *Journal of Research in Rural Education*, *22*(6), 1-16. Retrieved from http://jrre.psu.edu/articles/22-6.pdf

Slangen, L., Van Keulen, H., & Gravemeijer, K. (2011) What pupils can learn from working with robotic direct manipulation environments. *International Journal of Technological Design Education.* doi 10.1007/s10798-010-9130-8

Stake, R. E. (1995). *The art of case study research.* Thousand Oaks, CA: Sage Publications.

Stieler, C., Dittman, D., Schulz, N., Kopelke, K., Cannell, L., & Wilson, A. (2006). Girls and robotics. *Primary & Middle Year Educator, 4*(2), 10-12.

STEM Equity Pipeline. (2013). *Girls camps* [List of resources]. Retrieved from http://www.stemequitypipeline.org/Resources/OnlineResources/Programs/GirlsCamps.aspx

STEM Resources. (2013). *STEM resources for instructors to help women and girls: Annotated bibliography.* Retrieved from http://www.iwitts.org/store/educator-resources/stem-resources

Sullivan, A., & Bers, M. U. (2013). Gender differences in kindergarteners' robotics and programming achievement. *International Journal of Technology and Design Education, 23*(3), 691-702.

Thom, M. (2001). *Balancing the equation: Where are women and girls in science, engineering and technology?* New York, NY: Prentice Hall.

Tyler-Wood, Ellison, Lim, & Periathiruvadi (2012). Bringing up girls in science (BUGS): The effectiveness of an afterschool environmental science program for increasing female students' interest in science careers. *Journal of Science Education Technology.* doi: 10.1007/s10956-011-9279-2

U.S. Department of Education, National Center for Education Statistics. (1997a). *The condition of education 1997: Women in mathematics and science.* Office of Educational Research and Improvement (NCES 97-982). Retrieved from http://nces.ed.gov/pubs97/97982.pdf.

U.S. Department of Education, National Center for Education Statistics. (1997b). *State indicators in education 1997* (NCES 97-376). Retrieved from http://nces.ed.gov/pubs97/97376.pdf.

U.S. Department of Education, National Center for Education Statistics. (2009c). *U.S. Performance Across International Assessments of Student Achievement: Special Supplement to The Condition of Education.* Institute of Education Sciences (NCES 2009-083). Retrieved from http://nces.ed.gov/pubs2009/2009083.pdf.

U.S. Department of Education, National Center for Education Statistics. (2011). *The condition of education 2011*, Table A-26-2 (Report No. NCES 2011-033). Retrieved from http://nces.ed.gov/pubs2011/2011033.pdf

Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*, 89-101. doi: 10.1016/j.cedpsych.2008.09.002

Ward, R. B, Miller, J. L., & Sienkiewicz, F. & Antonucci, P. (2012). ITEAMS: Increasing the self-identification for girls and underserved youth in pursuing STEM careers. *Journal of Systemics, Cybernetics and Informatics, 10*(1), 95-99. Retrieved from http://www.iiis.org/CDs2011/CD2011SCI/EISTA_2011/PapersPdf/EA759DE.pdf

Waters, J. K. (2011, February 8). Rock 'em, sock 'em [Web blog post]. Retrieved from http://thejournal.com/articles/2011/02/08/rock-em-sock-em.aspx

White House. (2013). *Education: Knowledge and skills for the jobs of the future.* [Press release]. Retrieved from http://www.whitehouse.gov/issues/education

Williams, D., Ma, Y., Prejean, L., Ford, M. J., & Lai, G. (2007). Acquisition of physics content knowledge and scientific inquiry skills in a robotics summer camp. *Journal of Research on Technology in Education, 40*(2), 201-216.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching, 45*(9), 1036-1058.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal*, *37*(1), 215-246.

APPENDIX A

LETTER TO THE DISTRICT

December, 2013

Dear District,

I am writing this letter in hopes to receive an approval to conduct research for my dissertation at two middle schools in your district.

My name is Tricia Hyun, and I am currently a graduate student in the Educational Leadership Department of California State University, Fullerton (CSUF). Aside from my graduate studies at CSUF, I also teach language arts and history social science to 8th graders in the Fullerton School District.

In order to complete my Doctorate in Educational Leadership (Ed.D.), I need to complete a dissertation. My dissertation is on the shortage of females in science, technology, engineering, and mathematics (STEM) related fields. I am hoping to investigate the experiences and perceptions of middle school girls who are participating in a robotics curriculum. Through my study, I hope to understand why girls are not choosing STEM-related fields, and how classroom and curricular changes can impact a girl's perceptions and experiences of STEM fields.

If you have any questions, please feel free to contact me at (562) 331-2216 or my advisor, Dr. Karen Ivers, at CSUF. Her number is (657)-278-2470.

Regards,

Tricia Hyun

APPENDIX B

LETTER TO TEACHER

CSUF Letterhead

Dear ____________________,

My name is Tricia Hyun, and I am currently a graduate student in the Educational Leadership Department at California State University, Fullerton (CSUF). I am currently working on a dissertation with my faculty advisor, Dr. Karen Ivers.

I am pursuing a Doctorate in Educational Leadership (Ed.D.), and in order to complete my degree, I need to finish a dissertation. The purpose of my dissertation is to understand the experiences of middle school girls who are participating in a robotics curriculum. Currently, the nation faces a shortage of girls in science, technology, engineering, and mathematics (STEM) related fields. Through my study, I hope to understand why girls are not choosing STEM-related fields, and how classroom and curricular changes can impact a girl's decision to pursue or not pursue a STEM related field.

Your participation will involve an interview and will require approximately one hour of your time. I am happy to share the transcriptions with you upon availability. As a fellow teacher, I am seeking to better understand how educators can service students in such a way that is equitable. I am interested in finding out how middle school girls experience robotics. If you were to find any portion of the interview unsettling or distressing, you are free to withdraw from participation. You will not suffer any lack of benefits or services that you may otherwise be entitled to. Your participation is strictly voluntary.

The results of this study may be published but your name will not be identified and information you submit will be confidential to the extent allowed by law.

If you have any questions, please feel free to contact me at (562) 331-2216 or my advisor, Dr. Karen Ivers, at CSUF. Her number is (657)-278-2470.

By completing and returning the attached application, you are agreeing to participate in this study.

Sincerely,

Tricia Hyun

APPENDIX C

PARENT CONSENT

December, 2013

To Whom It May Concern:

My name is Tricia Hyun, and I am currently a graduate student in the Educational Leadership Department of California State University, Fullerton (CSUF). Aside from my graduate studies at CSUF, I also teach language arts and history social science to a diverse group of 8th graders in the Fullerton School District.

I am currently pursuing a Doctorate in Educational Leadership (Ed.D.), and in order to complete my degree, I need to complete a dissertation. The purpose of my study is to understand the experiences of middle school girls who are participating in a robotics curriculum. Currently, the nation faces a shortage of girls in science, technology, engineering, and mathematics (STEM) related fields. Through my study, I hope to understand why girls are not choosing STEM-related fields, and how classroom and curricular changes can impact a girl's decision to pursue a STEM related field.

Your daughter's participation will involve approximately two hours of her time. I will attend your daughter's class three times to observe and conduct interviews. Each interview will take between 30-45 minutes, and I am happy to share the transcriptions with you upon availability.

Your child is free to withdraw from participation at any time she wishes, and will not suffer any lack of benefits or services that you may otherwise be entitled to. Your child's participation is strictly voluntary and dependent on your approval.

The results of my study may be published, but your child's name will not be identified and information you submit will be confidential to the extent allowed by law.

If you have any questions, please feel free to contact me at (562) 331-2216 or my advisor, Dr. Karen Ivers, at CSUF. Her number is (657) 278-2470. By completing and returning the attached application, you are agreeing to have your child participate in this study.

Sincerely,

Tricia Hyun

APPENDIX D

INTERVIEW QUESTIONS

1) How do middle school girls participating in a robotics curriculum in two California middle school classrooms describe their experiences?
   a) Who decided that you would be in a robotics class?
      i) Did you decide/Did you sign up?
      ii) Did the teachers at the school decide?
      iii) Did your parents decide?
   b) When is the first time you remember hearing about robotics?
      i) What did you hear?
      ii) Did you talk to your parents or friends about robotics?
      iii) What was said?
   c) What did you know about robotics before taking this class?
      i) What do you remember about robotics that is different than what you know now?
   d) Can you describe a memorable event that has happened in the robotics classroom?
2) What do middle school girls participating in a robotics curriculum in two California middle school classrooms learn about robotics?
   a) What are robots? What are they made of?
   b) Do you know other kinds of robots?
   c) Why do people build robots?
   d) Is the robotics class like your science and math class or different?
   e) How is it like another class and/or how is not like any other class?

3) How do middle school girls participating in a robotics curriculum in two California middle school classrooms perceive STEM careers?

   a) Can you add the pronoun he/she to the below statements:

      i) The doctor placed ___ stethoscope on the table.

      ii) The teacher place ___plan book on the table.

      iii) The surgeon had ___ secretary call the patient.

      iv) The singer asked ___ vocals coach for a lesson.

      v) The scientist placed ___ clipboard on the table.

      vi) The mathematician earned an award for ___ effort.

   b) If you could be anything you wanted to be, how much would you like to have each of these occupations? (answers will be selected based on lists of careers. See Appendix E)

      i) I would REALLY LIKE to be a _____.

      ii) I would KIND OF LIKE to be a _____.

      iii) I would NOT LIKE being a _____.

      iv) I would HATE being a _____.

   c) Do you feel that you have the skills and abilities needed to be successful at these occupations?

   d) What occupations does society think are okay for women/men to be?

   e) What perceptions of STEM careers do middle school girls enrolled in a robotics curriculum have?

4) How do two teachers describe the performance of middle school girls participating in their robotics classrooms?
   a) How do you feel about the participation of girls in the classroom?
   b) How do you feel about the participation of boys in the classroom?
   c) Do the girls participate more than the boys?
   d) Do the boys participate more than the girls?
   e) Are the girls as engaged as boys?
   f) Are the boys as engaged as girls?

APPENDIX E

CAREER CLUSTERS

These "Career Clusters" come from Pettitt's study on "Middle School Students' Perceptions of Math and Science Abilities and Related Careers." She clusters careers into five different types: female sex-typed; male-sex typed; doctor/veterinarian; science related; and, non-sex-typed.

Female Sex-Typed:
Child care worker
Hair stylist
Nurse
Social worker
Teacher

Male Sex-Typed:
Airline pilot
Construction worker
Professional athlete
Professor

Doctor/Veterinarian:
Doctor
Veterinarian

Science Related:
Chemist/physicist
Computer scientist
Engineer
Natural Scientist/environmentalist/biologist

Non-Sex-Typed:
Artist/musician/actor
Business manager
Lawyer
Writer/journalist

APPENDIX F

QUESTIONNAIRE

Fill in the blank with one word, “his” or “her”:

1. The doctor placed ___ stethoscope on the table.
2. The teacher placed ___plan book on the table.
3. The surgeon had ___ secretary call the patient.
4. The singer asked ___ vocals coach for a lesson.
5. The scientist placed ___ clipboard on the table.
6. The mathematician earned an award for ___ effort.

APPENDIX G

RANDOMIZED CAREER CLUSTERS

Childcare worker

Hair stylist

Nurse

Social worker

Teacher

Airline pilot

Construction worker

Professional athlete

Professor

Doctor

Veterinarian

Chemist/physicist

Computer scientist

Engineer

Natural Scientist/environmentalist/biologist

Artist/musician/actor

Business manager

Lawyer

Writer/journalist

APPENDIX H

CLASSROOM OBSERVATION TALLY SHEET

Date:______________________
Observation:_______________

Observation:________________
Teacher:___________________
School:____________________
Room:_____________________
Researcher:_________________

Start Time of

End Time of

Grade Level(s):______
Females Present:_____
Males Present:_______

	Tally/Times observed date_______	Descriptive Note-Taking
Hands on activity/ Students are using their hands to accomplish a task	*(tally and descriptive)*	
Female student initiates conversation (whole class or small group)	*(tallies)*	
Male student initiates conversation (whole class or small group)	*(tallies)*	
Female student(s) hands goes up	*(tallies)*	
Male student(s) hands goes up	*(tallies)*	
Female student called upon by teacher (without raising hand)	*(tallies)*	
Male student called upon by teacher (without raising hand)	*(tallies)*	
Female achievement acknowledged by the teacher.	*(tallies)*	
Male achievement acknowledged by the teacher.	*(tallies)*	
Sexist comments by teacher	*(tallies with m/f about m/f)*	
Sexist comments by students	*(tallies with m/f about m/f)*	