Supporting Students Who Code: A Formative Evaluation of Elementary School Teacher Preparedness to Implement a Computer Science Program

by

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A dissertation submitted to the faculty of

San Diego State University

In partial fulfillment of the requirements for the degree

Doctor of Education

in

Educational Leadership

July 23, 2019

SAN DIEGO STATE UNIVERSITY

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Supporting Students Who Code: A Formative Evaluation

of Elementary School Teacher Preparedness to

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ABSTRACT

The underrepresentation of females in the computer science field has negatively impacted computer science programs in college and in the American work force. A possible cause of this problem is that schools are not giving equal access or providing equitable opportunities for girls to engage and explore computer sciences at a young age. Program efforts to attract students to code at an elementary school age will help to close the gender gaps that exist. The purpose of this program evaluation was to analyze, examine, and measure the interest level and effectiveness of a computer science coding program at an elementary school level before cultural and gender stereotypes play a role in determining student interest. This program evaluation was conducted at a new K-6 elementary school that is in the beginning stages of implementing a computer science coding program within the instructional day. A mixed evaluation method was conducted. Data collected were teacher surveys, student surveys, and one postevaluation teacher focus group. Teacher data were examined to determine if teacher mindset changed and whether or not they implemented professional development strategies learned to eliminate cultural stereotypes. Student data were examined and analyzed to determine if participation in the program had a direct effect on student's reported career choices and overall interest in computer science. The results of this evaluation prove that this program has provided female students a standing chance in continuing on the computer science pathway to eliminate the gender gap that exists in college and the American workforce.

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ACKNOWLEDGMENTS

I would like to thank the Chula Vista Elementary School District, Muraoka Elementary School, and the participants that engaged in this study. Thank you to the teachers of Muraoka and to Michael Bruder for being brave, innovative, collaborative, inclusive, and visionaries. You all are creating a 21st century learning experience for students. Your leadership gives students a standing chance in continuing on a STEM and computer science pathway to, hopefully, eliminate the gender gap that exists in the American workforce. Thank you for all you do for the students in the Chula Vista Community.

Dr. James Marshall, Dr. Nancy Frey, and Dr. Francisco Escobedo, my dissertation committee, and the Educational Leadership faculty, thank you for the countless hours and support you provided me throughout this journey.

Thank you to Dr. Erin Mahoney and Dr. Angela Rosendale for your support through this journey. We did it!

To my family and friends, you know who you are! I could not have done this without all of your support, encouragement, and love.

I would like to acknowledge all students. Anything is possible. May your future guide you down a STEM and computer science pathway.

This dissertation is first dedicated to the love of my life, my husband, David.
Thank you for the love, support, and guidance you provided to me during
one of the most challenging experiences in my life. You encouraged me
and gave me the strength I needed, when I needed it the most. You
have always been my biggest fan! Because of you, I was able to
to pursue my dreams. David, I love you with all my heart!
I can't wait to see what our future has in store for us.
This work is also dedicated to my two sons, David III and Zachary. You
are the fuel that lights my fire. Thank you for your unconditional
love and encouragement throughout this journey, and thank
you for your understanding when I couldn't be present.
Don't let anything get in the way of you pursuing
your dreams. Your dad and I can't wait to see
what you can do to change the world. Just
remember: Dare to Dream, Dare to Innovate,
and Dare to Inspire those around you,
because that's what Dare's do!
I love you both so much!
Lastly, to my parents, George and Victoria Hood. You truly are the best
parents anyone could ask for. Your love and support have helped
shape the woman I am today. Thank you for instilling
education, values, and love in all of us.
You are a true inspiration to us all.

CHAPTER 1—INTRODUCTION

As we progress in, and engage with, the 21st century, the underrepresentation of women in the computer science workforce continues to be problematic. With just 27% of computer scientists being female, the field has one of the lowest percentages of women among science, technology, engineering and mathematics (STEM) fields (National Science Foundation [NSF], 2019). This percentage has slowly increased over time, but gender equity is nonexistent (NSF, 2019). This gender gap is alarming.

The lack of females in computer science must be addressed at an early age, as early as elementary school. This begins with preparing teachers to be digitally literate. Multiple factors must be considered when working with children to help reduce gender disparities in the computer science field. Early on adolescents become stereotyped and, as a result, girls become less likely to have an interest in computer science relative to boys. In fact, according to Smith and Hung (2008), "Females are taught to believe from an early age that they are not equal to males, especially in math and science" (p. 245).

How does this interest fail to develop? Stereotypes may have a particularly negative effect in adolescence, when girls and boys develop their social identities, and schools increasingly offer introductory courses required to advance in science, technology, engineering, and mathematics (Master, Cheryan, & Meltzoff, 2016). Girls may be steered away—intentionally, or unintentionally—from computer science by parents, teachers, and others as they assert their beliefs that these careers are better suited for boys (Sadker & Sadker, 1994).

To combat the inherent bias students encounter, elementary school level leaders must recognize the need for computer science literacy early on, and for girls to have an opportunity to gain more experience. This, in turn, increases the chance of developing an interest in computer science, and ultimately pursuing a career in the field. Further research is needed to examine and measure the interest level and effectiveness of computer science and coding labs at an elementary school level before stereotypes play a role in determining female interest. Program efforts to attract girls to have an interest in computer science are critical components to gaining more interest and ultimately reducing the computer science gender gap.

While the elementary school leader has a significant role to play, the role of the teacher is also critical. It is crucial to have qualified and effective teachers to promote girls' engagement and interest in computer science. Saburo Muraoka Elementary School has implemented a coding program to prepare students to be digitally literate by learning basic computer science skills. It is assumed that the success of this program begins with both support from the school's leadership and well-trained teachers who successfully implement the program with their students. To understand the program's implementation, as well as investigate the program's early outcomes, an evaluation of the Koi Coding program at this elementary school was conducted.

The Koi Coding program is designed to prepare and build content knowledge so that elementary school teachers are equipped to teach computer science. Examining teacher preparedness through computer science professional development will be critical for student outcomes. Ajwa (2007) states, "The majority of computer science teachers across the nation have received minimal or no formal training in computer science" (p. 54). This is alarming because computer science is the literacy of the 21st century. Teacher preparedness is critical in teaching elementary school children these skills.

Thus, there is a need for elementary school teachers to learn and understand the content to be able to teach students.

Hsu, Purzer, and Cardella (2011) indicated:

> Despite the increasing emphasis on design, engineering, and technology (DET), at the elementary school level, benefits of DET education for children, and the urgent need for research-based teacher professional development, we know little about elementary teachers' perception to teach DET, their motivations to teach DET, and possible differences based on demographic factors such as gender, ethnicity, and teaching experience. (p. 32)

The ultimate goal is that teachers who receive computer science professional development will develop a growth mindset about teaching the content. Meierdirk (2016) describes a growth mindset as "the resilience to keep going when things get tough" (p. 25). Having a growth mindset is critical for teachers as they learn new concepts and skills that will prepare them to teach computer science to students. In addition, if computer science is taught at an elementary school level, it may help eliminate gender and cultural stereotypes and in turn increase the likelihood of students, specifically females, enter the computer science field.

Conceptual Framework

The Conceptual Framework that informs the program evaluation of the Koi Coding program presents a range of root causes related to computer science, and elaborates how, together, the lack of female interest exists in computer science. The Conceptual Framework illustrates the relationships that exist due to lack of teacher preparedness, which creates a gender gap in computer science (see Table 1).

Table 1

A Conceptual Framework Elementary School Teacher Preparedness for Coding

Inequalities in computer science	Gender disparities	Program efforts	Teacher preparedness
Lack of females working and majoring in computer science	Adolescent stereotypes	Minimal program efforts offered to elementary school students	Lack of professional development and preparedness for elementary school teachers
Low percentage of females in computer science classes	Cultural stereotypes	Lack of exposure to computer science at an elementary school level	Lack of support for teachers to implement computer science in elementary schools
Inequality in computer science among genders	Gender stereotypes	Lack of student exposure to computer science in elementary school	Lack of preparedness effects teacher mindset on teaching computer science
	Student mindset that males better suited for computer science		Lack of computer science knowledge with elementary school teachers

An evaluation was conducted to examine how the Koi Coding program efforts at an elementary school prepare teachers to teach computer science to students in kindergarten through sixth grade. The school's intent to provide such a program strove to eliminate the barriers that are displayed in Table 1. During the evaluation period, teachers were provided with professional development and curriculum support. Based on the professional development and curriculum support, the evaluation analyzed teachers' perception on whether the program has prepared them to teach computer science to students. Over time, it is possible that the effects of the program could increase student attraction, specifically females, to have an interest in computer science. Overall, the intent of the evaluation of the Koi Coding program examined the extent in which teacher support, including professional development and curriculum resources, impact teacher preparedness.

Statement of the Research Problem

Historically, women have been underrepresented in the computer science field. Some would say this lack of representation is due to the incorrect perception that females possess less cognitive skills that are required to excel in computer science. Research shows that the lack of female presence in the computer science field is surprisingly low. In fact, in 2013, girls in the United States entering college with the intent of majoring in computer science made up only 14% of all computer science graduates (Rubio, Romero-Zaliz, Mañoso, & de Madrid, 2015). This lack of representation is due to a range of influences that include gender stereotypes, and the lack of teacher preparedness.

It is important to recognize that students of today need to be taught computer science skills to become digital learners and digitally literate. When adolescents begin school, most elementary school teachers are ill equipped to teach students 21st century skills, specifically computer science. Our current standards call for the use of technology, but how are we incorporating those skills into our teaching and student learning at an early age? It is essential that young children be exposed to computer science at an early age to help attract girls into selecting courses that would put them on a track leading to a science/engineering major, and eventual career. According to Mulvey, Miller, and Rizzardi (2017), "Student interest in STEM declines by fifth grade because many STEM programs focus on older students, the need to build interest from early ages in imperative" (p. 120). It starts with preparing elementary school teachers to be digitally literate and apply that literacy to everything they do in the classroom.

Coding is the digital literacy of our future, so how are we preparing for our future, specific to these skills? When teachers are ill equipped with resources, then students are not provided with opportunities to learn the skills needed to keep up with the 21st century learning environment. Exposing teachers and students to coding at an elementary school level will not only raise the interest level in students, but the interest of teachers, as well. According to Cheryan, Master, and Meltzoff (2015), “By broadening the representation of people who do this work, the work itself, and the environments in which they occur—significantly increases girls’ sense of belonging and interest in the field” (p. 1). There needs to be a gender-neutral approach where both females and males have equal access and opportunities to learn coding. Elementary schools need to begin to expose students to these opportunities to prevent a disparity between genders.

Along with learning 21st century skills, teachers need to develop a growth mindset in the areas of computer science support students. Teaching computer science to students needs to be part of our daily curriculum and tied to our daily content activities. It should not be a separate learning experience. The opportunity for students to learn computer science through a variety of content will show students the alignment of how they can become future computer scientists.

Purpose of the Program Evaluation

The purpose of this program evaluation was to determine if the Koi Coding program is being implemented as designed and meeting the outcomes it was designed to achieve. The evaluator sought to understand the impact of how teacher preparedness in computer science and coding aid in the development of their skills and knowledge so that teachers are better equipped to teach students. This evaluation examined the effects of the school's efforts to engage students in a series of computer science and coding lessons. Over the course of 7 weeks, all students in grades second through sixth took part in school designed coding lessons and program implementation. Strategic planning and implementation of the school-designed program may help increase student interest in the computer science field. Evaluation findings described the extent to which teachers' preparedness to teach computer science has an effect on students learning to code. Ultimately, if students are engaged in the program, will they have an immediate, increased desire or interest in the computer science field?

Evaluation Questions

Computer science has one of the lowest percentages of women among science, technology, engineering, and mathematics. To focus this study, the evaluation questions were as follows:

1. Is the Koi Coding Program implemented with fidelity, as measured by the program's defined implementation guidelines?
2. Over the course of the evaluation period, what strategies have the teachers learned, through professional development and curriculum implementation, that would play a role in creating a gender neutral approach to computer science?
3. Has the Koi Coding program, and the professional development component in particular, resulted in mindset changes for participating teachers, including the application of strategies to eliminate cultural stereotypes in computer science? If so, in what ways?

4. What impact, if any, does the implementation of a 7-week coding program have on students' reported career choices and interest in computer sciences?
5. Do student outcomes differ based on the quality of the program's implementation?

To answer these questions, this study uncovered the effects of the Koi Coding program to attract school age girls to computer science and the professional development for elementary school educators.

In the summary of relevant research that follows, I will first examine the various factors that led up to the root cause. I will then look at how the lack of teacher knowledge interferes with the implementation of computer science in the classroom. Next, I will examine the importance of how coding programs its effect on student interest in computer science. Lastly, I will provide a brief description of the program that will be evaluated for this research.

Summary of Relevant Research

The underrepresentation of females in the computer science field has negatively impacted computer science programs in college, thus having a direct effect on in the workforce. A possible cause of this problem is that schools are not giving equal access or providing equitable opportunities for girls to engage and explore computer sciences. There are various stereotypes that contribute to the gender gap that exists in computer science, and they begin at a very early age. In fact, according to Quinn and Cooc (2015), gender gaps play a significant role for the lack of technical progressions and social equity in the computer science field. Chapter 2 will closely look at how adolescent stereotypes, gender stereotypes, cultural stereotypes, and identity threats play a role in the creation of the gender gap that exists in computer science. Each stereotype and threat create a pathway that leads students deciding their educational and career path. Computer science opportunities are rarely offered to elementary school students, where many of these stereotypes are developed and molded by society and the students' educational experience. In fact, elementary school teachers, whether positive or negative, influence student stereotypes and their overall interest in computer science.

Teachers have a direct impact on students and their learning. Unfortunately, many elementary school teachers are not equipped nor prepared to teach computer science to their young students. Nam, Seung, and Go (2013) explore the science education reform movement, which draws attention to the importance of aiming to improve scientific literacy for all. Teachers need to be provided with educational tools and support to ensure students are prepared for the 21st century, and it begins with program efforts.

Program efforts to attract students to code at an elementary school age will help to close the gender gaps that exist. Students at a K-6 elementary school level are not being provided with ongoing exposure and practice with computer science to prepare them for the future. To examine the key issues, this research explored and analyzed a school's efforts to provide K-6 students with computer science/coding lessons and the impact that it had on student perception of the program. The study was conducted on a new K-6 elementary school that was in the beginning stages of implementing computer science coding opportunities within the instructional day. The intent of this program evaluation was to analyze, examine, and measure the interest level and effectiveness of computer science coding labs at an elementary school level before cultural stereotypes play a role in determining interest. In addition, the study examined the role of professional development for elementary school teachers and how it shapes their mindset and prepares them to teach computer science.

Description of Proposed Methodology

Examination of the literature included in this study focused on four major areas: stereotypes, teacher/student mindset, computer science program efforts, and lack of teacher preparedness as it relates to computer science. The literature review examines the root causes for the lack of women in computer science and supports the need for this program evaluation. The evaluation of the Koi Coding program examined teacher preparedness to teach computer science to elementary school students. This program evaluation included both teachers and students in grade second through sixth. The evaluator collected both quantitative and qualitative data throughout the program evaluation period. Qualitative data collected included input from teachers in kindergarten through sixth grade. In addition, survey data from students in grade second through sixth were collected prior to, and following, the program to evaluate whether or not participating in the program had an effect on interest in computer science and additional outcomes targeted by Koi Coding. Responses were compared based on student gender. The combined data sources strengthened the findings of the effects the program had on both teachers and students.

Limitations

As with every evaluation, this study had limitations. First, this study was conducted in a single school setting, which limited the extent to which its findings could be generalized. The data collected from the study described the extent to which the effectiveness of an elementary school coding program, if implemented with fidelity, has an impact on teacher mindset and create a gender-neutral approach to computer science. Furthermore, it must be noted that the researcher served as the principal in the elementary school at the onset of the study. The findings, therefore, may inadvertently include a bias.

Significance of the Study

According to Ajwa (2007), "Computer science is a mainstream discipline that can no longer be ignored by public schools in the 21st century" (p. 56). In fact, many teachers lack the skills and knowledge to adequately teach computer science. For the purpose of this student, computer science skills are defined as having the ability to read and write code. In addition, the computer science skills in this program would include, but are not limited to: be creative, understanding coding tools, challenging one's self, working collaboratively, be logical, and be a mathematic. Computer science is the literacy of the future, and students in school today need to be taught those skills. In fact, according to Ajwa, "America's competitive edge in today's world depends on an educational system capable of producing young people and citizens who are well prepared in science and math, including computer science" (p. 54). Moreover, the lack of teacher knowledge may have a direct effect on why they may not teach computer science to students. Teachers feel they are not prepared to teach design, engineering, and technology, but indicated these are important skills that students in K-12 classrooms should know (Hsu et al., 2011).

This study examined the effectiveness of an elementary school program that is designed to counteract many of these computer science-related challenges. The evaluation examined the extent to which teachers create a gender neutral approach to computer science through preparation for, and implementation of, the Koi Coding program. Exposing teachers and students to coding at an elementary school level will not only raise the interest level in students, but teachers as well. The researcher examined a school's computer science/coding program and how professional development plays a role in the teacher's mindset to teach these new skills.

CHAPTER 2—REVIEW OF LITERATURE

Over the course of years, as the 21st century learning environment began its development, an alarming phenomenon occurred. As our digital world continues to advance, the shortage of females in the computer science field has lacked a strong equitable presence. This is due in part by the lack of teacher preparedness, gender disparities, teacher/student mindset, and program efforts for students at an elementary school age. Although research suggests that the gender gap exists, very little can be found on the effects of teacher preparedness to close the gender gap. To fully understand the impact of the underrepresentation of females in the computer science field, this review of literature examines the various aspects that contribute to the gender gap. According to Ajwa (2007), that is due in part to "teachers across the nation have received minimal to no formal training in computer science and, as a result, are faced with unique challenges" (p. 58). Unfortunately, the gap begins at a very young age, and underprepared teachers aid in that development as gender disparities and stereotypes are created in both school and home. There are various forms of stereotypes, but this research will focus primarily on gender and cultural stereotypes. These stereotypes best support the research of why gender disparities exist in computer science.

Throughout this review, the term *gender* will be used. The American Psychological Association (2015) defines it as:

> The attitudes, feelings and behaviors that a given culture associates with a person's biological sex. Behavior that is compatible with cultural expectations is referred to as gender-normative; behaviors that are viewed as incompatible with these expectations constitute gender non-conformity. (p. 71)

It is important to understand this term and how it relates to the research.

The literature review will describe how professional development plays a role in shaping the mindset of a teacher to become more accepting of, and willing to, teach in a more gender neutral way. According to Meierdirk (2016), “Teachers have an important part to play in the mindset of pupils. They themselves can encourage growth or reinforce fixed mindsets” (p. 25). When considering the impact of the teacher and how he or she shapes the minds of young students, mindset plays a leading role. In fact, according to Dweck’s (2010) research, “Having a growth mindset is especially important for students who are laboring under a negative stereotype about their abilities” (p. 26). This literature review examines the impact of teachers and how they foster growth mindset with their students, especially females in computer science. Students who have a growth mindset value their own effort.

Stereotypes

For many years, females have been underrepresented in the computer science field (Ruble, Martin, Berenbaum, Damon, & Eisenberg, 2006). Children begin to understand gender stereotypes at a very young age. Recent research suggests that even before 30 months of age, some children understand gender stereotypes (Ruble et al., 2006). At birth, children are stereotyped and associated with pink as a color for girls, blue for boys, and green or yellow if the sex is unknown. Not only does society stereotype girls to wear pink, they stereotype girls to play with Barbie dolls, cook in a play-set kitchen, be a princess, like art, and much more. Boys, on the other hand, wear blue; play sports, like fast cars, and like science and math. Such common practices support the creation of gender stereotypes among the youth.

Historically, the United States has a low percentage of women in the computer science field. This outcome may be attributable, at least in part, to a wide range of experiences young people encounter. Gender stereotypes are among the earliest, but the coursework during middle and high school likely contributes, as well. As students enter secondary school and higher, male student enrollment in math and science outnumber female student participation. In the United States, the belief that males are somehow more adept in mathematics is common. Smith and Hung (2008) concluded that "once a young girl becomes cognizant of stereotype threats, could result in causing her performance on math-based tests to become affected" (p. 244). The NSF (1996) conducted a study and concluded that gender stereotype in the area of mathematics prominently emphasizes that females possess less natural ability than males in mathematics. Society, along with parents, lays the foundation for children, thus creating adolescent stereotypes. Although stereotypes exist in many facets of life, this review of literature will closely examine the impact of culture and gender stereotypes. The relationship between both are significant in this research as they impact female interest in computer science.

Cultural Stereotypes

There are various forms of stereotypes that exist in our world today. Stereotypes can exist in many forms and are often connected to someone's race or culture. Stereotypes are created by people and are developed when one perceives something and that belief shapes their opinions. Cultural stereotypes have a direct effect on the lack of females entering the STEM and computer science fields. Master and Meltzoff (2016) conducted a study which found that "cultural stereotypes are internalized in children's minds and begin to shape their beliefs about what field is for them and where they belong" (p. 216). As with adolescent stereotypes, society creates the path for students and their futures. Figure 1 depicts how cultural plus ability stereotypes create STEM stereotypes.

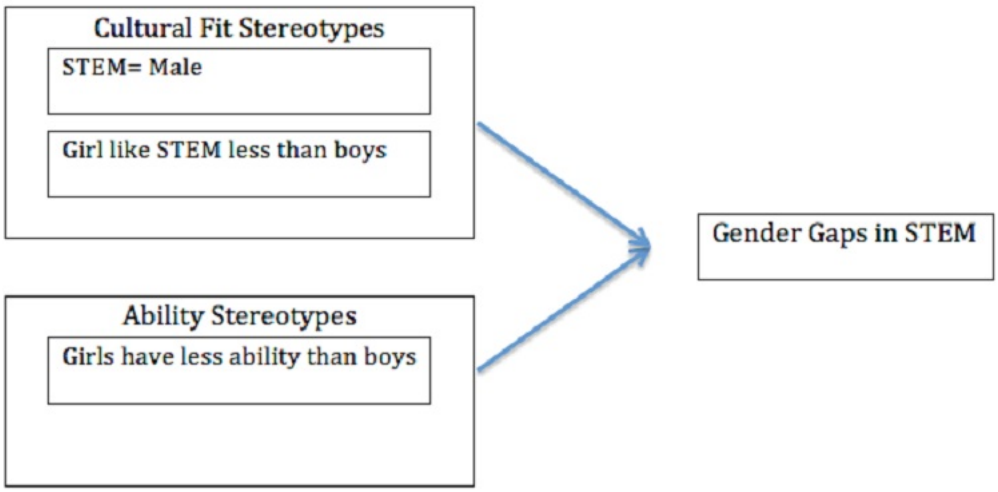

Figure 1. Gender gaps in STEM. Adapted from "Building Bridges Between Psychological Science and Education: Cultural Stereotypes, STEM, and Equity," by A. Master & A. N. Meltzoff, 2016, *Prospects: Quarterly Review of Comparative Education, 46*(2), p. 217.

The two stereotypes signal to students the idea about who "fits" in STEM and who has the ability in STEM. The figure clearly outlines that females do not belong in STEM due to cultural fit and ability stereotypes (Master & Meltzoff, 2016). As children develop through school, stereotypes are created or, in some cases, exist prior to beginning school. Both cultural fit and ability stereotypes contribute to the gender inequities in STEM. Cultural fit stereotype attracts males into the STEM field while leaving behind girls. As adolescents develop, parents, teachers, and society play a factor in contributing to the development of ability stereotypes. It is important to understand the relationship of how cultural stereotypes create gender gaps in computer science.

Gender Stereotypes

At a young age, children become more aware of the gender stereotypes that exist. In fact, children as young as 6 years old are aware of the societal labels and begin to develop likes and wants based on those labels. McKown and Weinstein (2003) wrote that children's stereotype consciousness comes at an early age, from all ethnic groups, and it is at that time that children begin to experience academic stigmatism. The labels that are developed continue to morph as children mature and become stronger over years.

Gender stereotypes, as it relates to this research, is described as males being better suited for STEM and who have greater success in STEM than females. The idea that males are better suited for STEM has existed for years, thus affecting the female mindset and participation in the field. Spencer, Steele, and Quinn (1999) researched females and their mathematic ability as it relates to gender-based stereotype threats. In the research, they found that the ability to do well in math weakened when the subjects feared being judged, thus causing underperformance. According to Gunderson, Ramirez, Levine, and Beilock (2011), "Women's math abilities are transmitted to girls by their parents and teachers—as early as preschool and elementary school—shaping girls' math attitudes and ultimately undermining performance and interest in science, technology, engineering, and math (STEM) fields" (p. 153). Although there has been a lack of female representation in STEM as compared to males, the research shows that since 1970, more females in the field are on the rise, but not at the rate in which equality in genders exist (Sax et al., 2016). Gender stereotypes are directly related to cultural stereotypes and are developed through bias within our society. As gender stereotypes exist, so does the underrepresentation of women in the STEM fields and contribute to stereotype threats.

Stereotype Threats

As cultural and gender stereotypes impact female interest in computer science, so do stereotype threats. Block, Koch, Liberman, Merriweather, and Roberson (2011) defined stereotype threats as where one is

> underrepresented, and thus in the demographic minority, has been shown to be a factor leading to the experience of stereotype threat—the expectation that one will be judged or perceived on the basis of social identity group membership rather than actual performance and potential. (p. 570)

Stereotype threats have widely been studied in social psychology. In fact, research indicates that socio-stereotypes can sometimes have an effect on the academic outcomes on individuals, particular females in STEM (Thoman, White, Yamawaki, & Koishi, 2008). Roberson and Kulik (2007) suggest that females had a decrease in performance when compared to their male counterparts due to stereotype threats. In fact, Block and colleagues (2011) summarized the work of Roberson and Kulik, which stated that the following conditions attributed to creating stereotype threats:

> (a) the task an individual is performing is relevant to the stereotypes about an individual's group, (b) the task is challenging, (c) the individual is performing in a domain with which he or she identifies, and (d) the context in which the task is being performed is likely to reinforce the stereotypes. (p. 572)

According to Smith and Hung (2008), stereotype in STEM could "create internal barriers inhibiting success by increasing low self-esteem, dashed hopes for the future, or even lost confidence due to an environment allowing stereotypes to occur" (pp. 247-248). While stereotype threats create a barrier in computer science, so does STEM identity.

STEM Identity

STEM identity is created in both males and females throughout their educational careers. Just as STEM identity makes a positive impact on male presence, the negative impact has impeded female interest. Steinke (2017) describes how individuals create a STEM identity by being self-constructed, malleable, and change as one reacts to events. Negative STEM identity is created when females are exposed to educational settings that lack support in creating gender equality (Ramsey, Betz, & Sekaquaptewa, 2013). Just like gender stereotype develops at an early age, so does STEM identity. The development of STEM identity must begin in adolescence with the support of parents and educators. In addition, STEM professionals play a key role in attracting female interest in the field, especially when adolescence females are exposed to and view media images. Ramsey and colleagues (2013) stated that girls, during adolescence, actively consider future personal and professional identities.

As STEM awareness becomes more prevalent in schools, the role of female presences has increased, thus creating an increased identity. Unfortunately, the increase is happening at a very slow pace. Therefore, reducing their stereotyping concerns may be important for increasing women's participation in STEM as students and professionals. Strengthening STEM identity is a key component to ensuring females have a presence in the field.

The Impact of Mindset: Female Interest in Computer Science

Research suggests that the mindset of females plays a role in their desire to develop in the area of computer science. Research also suggests gender and teacher influence one's mindset; therefore, fostering a growth mindset at an early age may have a direct effect on female participation in computer science. According to Dweck (2010), "When female students adopt a growth mindset, their grades and achievement test scores in math become similar to those of their male classmates" (p. 29). In fact, Dweck also found that students who foster a growth mindset achieve academically even in the face of stereotypes.

For the purpose of this research, it is important to understand the difference between fixed and growth mindset to see how their relationship affects female interest in computer science. In addition, it is important to understand how teacher mindset may or may not impact students and their ability to learn computer science. Teachers with a growth mindset about learning computer science may provide more learning opportunities for students, thus impacting females and their desire to learn to code.

Fixed Versus Growth Mindset

Over the past few years, research has been conducted to determine if one's mindset affects the way one learns. The research reviews two types of mindsets: fixed and growth. Both are believed to have either a positive or negative impact on one's learning and their success. Haimovitz and Dweck (2017) stated that the difference between a growth and fixed mindset is that children with more of a fixed mindset believe that they have a certain amount of ability, and they cannot do much to change it. Teachers across the country are learning more about how to foster a growth mindset in children to positively impact their learning outcomes. This is important because as children develop and engage in learning at any level, they begin to develop a mindset. It has been researched that fostering a growth mindset allows for children to excel, while fostering a fixed mindset does the opposite. In fact, Haimovitz and Dweck concluded "children with more of a growth mindset instead believe that they can develop their abilities through hard work, good strategies, and instruction from others" (p. 1849).

In recent years, teachers have become much more aware of the research and are incorporating ways in which to expose and foster a growth mindset with their students. Young students are becoming more aware of the impact that their mindset has on learning. Hochanadel and Finamore (2015) wrote that students who "value effort and perceive ability as malleable skill are said to have a growth mindset" (p. 48). Just as mindset is important for students, it is just as important for teachers. Classroom success begins with teacher mindset.

Teacher Mindset

Teacher mindset holds the key to influencing and impacting student learning. In elementary school, teachers have the ability to shape the mindset of children, while teacher mindset impacts the way one teaches. Teachers with a fixed mindset, who feel they are not proficient in science, technology, engineering, math, or computer science could have a negative impact on students. According to Dweck (2010), "Resent research has shown that students' mindsets have a direct influence on their grades and that teaching students to have a growth mindset raises their grades and achievement scores significantly" (p. 26). A German researcher by the name Rheinber (as cited in Dweck, 2010) conducted a study to measure teacher mindsets. After the conclusion of his study, he was able to determine that when teachers had a growth mindset they were able to raise students to a whole new level. Students who started the school year as low achievers, moved up. To achieve this, teachers with a growth mindset or openness to learning and teaching STEM have a direct effect on student learning and academic outcome. Teachers and administrators should send messages to students that foster and possess a growth mindset that impacts their intelligence and that message must be shared time and time again.

Female Interest in Technology, Engineering, and Computer Science

Academic environments can feel unwelcoming for women in science, technology, engineering, and math fields (Ramsey et al., 2013). In fact, according to Sax and colleagues (2016):

> The overall level of interest in engineering has fluctuated between 1971 and 2011, a very large gender gap in freshman interest remains. We find that the percent of first-year women who plan to major in engineering is roughly the same today as in the early 1980s. (p. 570)

The underrepresentation of women in engineering is due in part to stereotypes, mindset and underprepared teachers who teach STEM and computer science. As adolescent females develop their likes and dislikes, science and math are at the forefront of content areas that females tend to shy away from. As females progress through school, the environment becomes more and more unwelcoming. Murphy, Steele, and Gross (2007) found that when men greatly outnumber women, it creates an environment that is unwelcoming. In fact, Ramsey and colleagues (2013) suggest that "over time, these environments may lead women to develop negative beliefs about their participation in

STEM, inhibiting their success and encouraging them to choose other fields for their major or career" (p. 378).

It is evident through research that there is an underrepresentation of women in STEM. Ramsey and colleagues (2013) suggest that "increasing women's identification with STEM, increasing their expectations for female representation, and reducing their stereotyping concerns may be important for increasing women's participation in STEM as students and professionals" (p. 377). This review earlier suggests that stereotypes play a key role in developing the mindset of females in STEM. Rubio and colleagues (2015) researched that computing and introductory programing courses need to change in order to get more women involved in the field. In addition, courses need to begin at an earlier age, so that females have an opportunity to develop their own biases related to computer science.

STEM Program Efforts for Young Children

With the transition to 21st century learning, educators have relied heavily on developing computer and Internet skills. STEM is a new learning skill that encompasses more than just science knowledge and is integrated at an elementary school level. The greatest change in the NGSS standards is the integration of engineering and computer science, skills that were not included in the former standards. Teachers are expected to teach, learn, and implement these new skills with minimal professional development, resources, and support. Current instructional practice is on the development of hands-on experiences for students, which provide and support a variety of learning styles. According to Umrani-Khan and Iyer (2009), computer fluency can be reinforced through hand-on experience, computer games, and puzzles which can support the adoption of the standards and the integration of technology. They also suggested that literacy to include reading, writing, and arithmetic, which are relevant to acquiring computer and Internet skills. Coupled with computer and Internet skills, the Next Generation Science Standards (NGSS) propose the integration of engineering knowledge into science education (NGSS Lead States, 2013).

Gender Gap in STEM

The gender gap in engineering presents a significant problem within the American educational system and job field. According to Master and Meltzoff (2016), the gender gap in STEM education presents a worldwide problem of inequity. Current youth are at the forefront of gender equity and tend to choose very traditional science subjects and careers particularly in STEM subjects, which are largely male dominated (Sinnes & Løken, 2014). Master and colleagues (2016) conducted research and found that girls, when compared to boys, feel a loss of belonging due to stereotypes. In fact, their research found that girls who do not fit the stereotype "show reduced belonging and interest in a computer science" (p. 426). Providing girls with a nontraditional educational environment, one that is positive, may increase their interest in computer science and STEM, thus reducing the gender gap.

As students develop their STEM abilities, there are various practices that support the learning. According to Kelly, Cunningham, and Ricketts (2017), "The NGSS standards advocate for three-dimensional learning comprised of science and engineering practices, crosscutting concepts, and disciplinary core ideas" (p. 48). New NGSS standards outline expectations that teachers are expected to teach the standards that develop and support student learning in a variety of way. Kelly and colleagues found that multidimensional learning supports students specifically with engineering, which they call "three-dimensional learning." Kelly and colleagues explain that this type of learning is more of an approach to learning and recognizes "the ways that substantive disciplinary knowledge interacts with choices about practices and uses of specific and generalized concepts and ideas" (p. 48) rather than focusing on process and science skills. As students and teachers develop their understanding of STEM, there are various ways to support the learning. With the development of engineering, opportunities for STEM greatly increase, giving students at an earlier age access to this type of learning.

Developing Digital Literacy

It is said that the literacy of the future is knowledge of technology and computer science. In the 21st century learning environment, students explore and utilize digital texts to become proficient readers and writers (Neumann, Finger, & Neumann, 2017). According to Umrani-Khan and Iyer (2009), conceptual understanding, technology skills, and algorithmic thinking, along with a growth mindset, will assist in becoming fluent with computer technology. At a young age, digital literacy is developed along the same rate as reading development. Children begin to read or recognize digital icons, just like they would with letter and letter sounds in reading. As they develop and recognize more digital icons, they are in the emergent stages of digital literacy. As students learn to become more digitally literate, their ability to code will increase. Learning to code is like learning to read. This skill prepares students for the digital future to be STEM and computer science literate.

Developing STEM and Computer Science

Computer science and STEM are at the emergent stages of implementation in the elementary school setting. Teachers are becoming more proficient in using devices and programs in the classroom; however, explicit teaching of STEM and computer science is not as prevalent as other content areas. Nager and Atkinson (2016) found that "despite the growing use of computers and software in every facet of our economy, not until recently has computer science education begun to gain traction in American school systems" (p. 18). Computer science is a growing field and efforts to teach children these valuable skills are a necessity to building a digital literate future. In fact, Figaro-Henry and Kamalodeen (2015) predict that in order to sustain a thriving economy in the future, careers that involve STEM literacies must be present.

Lack of Teacher Preparedness in STEM

With the new science and technology standard adoption, professional development is key to the success of students and teachers, especially in preparation of creating digital learners through computer science. Capraro and colleagues (2016) affirmed, "Sustained professional development can support STEM (Science, Technology, Engineering, and Mathematics) reform" (p. 181). As students become digital learners, computer science education and professional development is critical for teachers.

In order for educators to succeed with 21st century teaching, teachers must have the opportunity to understand and become comfortable teaching STEM content. Polly (2015) indicated that teacher education programs have a duty to prepare new teachers to be effective at teaching 21st century skills. The problem that arises is that teachers who have been out of a teacher education program will not have the same opportunities as those going through a program that focuses on 21st century learning skills. In fact, Polly also states that "the responsibility of preparing future teachers with the skills and knowledge needed to effectively integrate of technology into their classroom" (p. 431). Capraro and colleagues (2016) formed a committee in which they conducted a study on the impact of STEM professional development for teachers. In the study, the committee recommended a call for increased recruitment of science and mathematics teachers, expanded teacher education, promote and create a STEM pipeline in K-12 education, increase research funding, and adopt economic policies that would foster innovation.

Teachers need to be prepared to teach, which is essential to their success. Figaro-Henry and Kamalodeen (2015) stated that in order for STEM to be successful in schools, teachers need training and resources in order to "empower students with skills needed to master curricula and boost creativity" (p. 182). Professional development and training for teachers is critical to teacher and student success. Teachers must be fully equipped to educate children in the 21st century. To further understand the impact on 21st century skill development, analogous research was conducted and reviewed.

Analogous Research

Analogous research was reviewed to inform this literature review. This research is important as it outlines the importance of teacher development and reviews key findings. One similar research effort was titled *Developing 21st Century Skills in In-service Science Technology Engineering and Mathematics (STEM) Teachers Through Digital Learning Spaces (DLS)* by Figaro-Henry and Kamalodeen (2015). This study explored how its authors, Figaro-Henry and Kamalodeen, provided STEM in-service to teachers and how they participated in "various digital learning spaces and what 21st

Century skills they were able to develop through these STEM professional development spaces" (p. 182).

The article closely looks at the importance of digital learning spaces in education, STEM education, in addition to STEM skills for professional development. This is extremely helpful in educational practice, so that educators can see the impact that teachers have on teaching 21st century skills, specifically in the STEM field. According to Figaro-Henry and Kamalodeen (2015), this research is important as it identifies how online professional development uses digital learning spaces and collaborative environments to assist in the promotion of "learning together with formal training sessions as enabled by Web 2.0" (p. 182). The following sections review the research questions used, the review of literature, methodology used, statistics and results of the study.

Research Questions

Figaro-Henry and Kamalodeen's (2015) research was guided by the following questions: (a) "Did the digital learning spaces affect in-service STEM teachers' digital technological skills?" (p. 184); (b) "What 21st century skills did the in-service STEM teachers develop through the digital learning spaces?" (p. 184). Based on the questions, the type of research is evaluative. The hypothesis was that "digital learning spaces positivity affected all in-service STEM teachers and improved digital technological skills" (p. 185). In general, new skills were gained and all participants made improvements.

Literature Review

The literature that was reviewed was used to look at "the affordances of digital learning spaces for teachers and how the teachers developed 21st century skills through using digital spaces" (Figaro-Henry & Kamalodeen, 2015, p. 183). The review included a look at the historic importance of digital learning spaces over the past 10 years, the importance of digital learning spaces professional development for teachers, various DLS models, and importance of STEM literacies and teacher-education. The literature review does support the hypothesis that digital learning spaces positively improve digital technological skills in teachers.

Methodology

The type of methodology used in the research was mixed methods of qualitative and quantitative research, as proposed by Johnson and Onwuegbuzie (2004). The sampling technique that was used was nonprobability sampling where members were selected in a nonrandom manner. The participants were as follows:

- Ten Early Childhood Care and Education, 40 Primary, and 50 Secondary teachers
- Majority trained (70%) had postsecondary education
- Twenty-five schools across the island of Trinidad were purposively selected.

The participants were selected to participate in the STEMagination program where data were collected through blogs, wikis, discussions, forums, and other digital spaces while using the Web 2.0 tools. Participants were hand selected to participate in the study. It was clear that biases within the research were that teachers are ill equipped to teach STEM and need professional development. The research was limited to teachers on the island of Trinidad and did not show a comparison to teachers in the United States. There were various tools to measure and collect data in the research. The data research tools included:

- Pre-survey/initial survey to assess the level of existing technology skills
- Wiki interactions—edits and dates and authorship for collaboration
- Discussion forum posts—discussions under themes for inquiry
- Blog posts and authors for reflective thinking
- Skype and emails for synchronous and asynchronous communication
- Prezis for presentation.

Once the data were collected, the researchers analyzed their findings. The two independent variables were exposure to a digitally rich environment and selecting digital learning spaces "to allow teachers with a range of entry technological skills to use the spaces easily from a distance on their own time" (p. 189). Data were collected in the following areas:

- Technological skills developed by STEM teachers in various DLS
- Skills gained by teachers across EC, Primary, and Secondary levels
- Blog post replies
- Discussions from online posts and replies
- Teacher PowerPoint presentations
- Reflection replies to posts by teachers

The outcome was positive as teachers gained skills in the digital learning spaces listed above.

Statistics

Figaro-Henry and Kamalodeen (2015), include both narrative and tables (p. 184-189) to describe the research data. There were examples of discrete variables that were used in this study. The use of a 5-point scale ranging from 5—high satisfaction to 1—low satisfaction for survey data. It was evident that the researchers examined multiple pathways to analyze the data and the users of the program to determine next steps and user needs.

Results and Discussion

Figaro-Henry and Kamalodeen (2015) concluded that the use of digital learning spaces and the tools that were used "allowed for teachers to demonstrate 21st century skills of communication, collaboration, critical thinking and presenting to support and promote participation in online professional development" (p. 189). The implications were "mentoring or peer interactions is important for long-term sustained communications and maintaining interest in virtual learning spaces" (p. 189).

The summary of the study was helpful in looking at the impact of teacher preparedness through professional development. In the following section, a description of the program that will be evaluated in this research will be reviewed. Like the analogues research, the program is designed to enhance teacher knowledge and prepare them to teach computer science skills to elementary school children.

Description of the Koi Coding Program

Computer science teacher preparedness is lacking in our elementary educational system. Teachers are underprepared to teach this skill to students due to the lack of professional development available to teachers. A new school in the Chula Vista

Elementary School District opened its doors on July 19, 2017 with the intent of creating a program that would develop teacher knowledge in the area of computer science and prepare these educators to impart that knowledge to their students.

Computer science, in particular coding, is the literacy of the future. Students in the future will need to learn coding, just as they need to learn to read. This program was developed to reach elementary school students to develop their computer science skills and spark their interest in field. The intent of the school's coding program is to build digital literacy through the development of computer science skills. The program is designed to include teachers who teach in second through sixth grade. Teachers will engage in professional development to learn about coding devices and learn to code. Table 2 is a Logic Model that outlines the program, audience, impact, and output.

Curriculum Map

The program just completed one year and is in the developmental stage. The focus for year one of implementation was on designing the labs, developing norms, introducing the program devices, and creating and implementing the program components. A curriculum map differentiated by grad levels was developed to ensure access to all students in Kindergarten through sixth grade. Figure 2 outlines the curriculum map and the coding instruments used in year one and will continue to be used in year two.

Program Fidelity

Using the Koi Coding program as designed is intended to provide students with an opportunity to develop computer science skills. For the purpose of the program evaluation, teachers must use the program at least three times per week for 30-45 minutes

Table 2

Logic Model

		Outcomes	
Inputs	Processes	Short-term	Long-term/impact
Audience: • Parents • Teachers • Students • Parents Technology • Access to technology • Coding lessons • Code.org • Professional Development Trainers • Coding Tools appropriate for grade levels Curriculum • Onsite professional development • Developed and shared with all teachers in grades K-6 • Co-planning to meet the needs of each individual teacher and grade Administration • Coding Team • Ongoing Professional Development Presentation • Classroom Support • Ongoing Curriculum Development	Teacher Professional Development Co-teaching—teachers and digital media arts teacher Teachers will implement the onsite-coding program at least three times per week Students will utilize the program three times per week Students engage in the learning and progression of the coding lessons as designated by teachers	Students will • Students exposed to coding labs 3 times per week to build, strengthen knowledge, and enhance interest Teachers will: • Develop skills and knowledge to teach computer science • Create a gender neutral approach to teaching computer science • Teacher mindset is developed to support their learning of new content • Teacher learn about coding and how to teach coding	Students will • Develop 21st century skills • Build digital literacy skills • Learn to code • Equality in computer science among genders • More females enter the computer science field

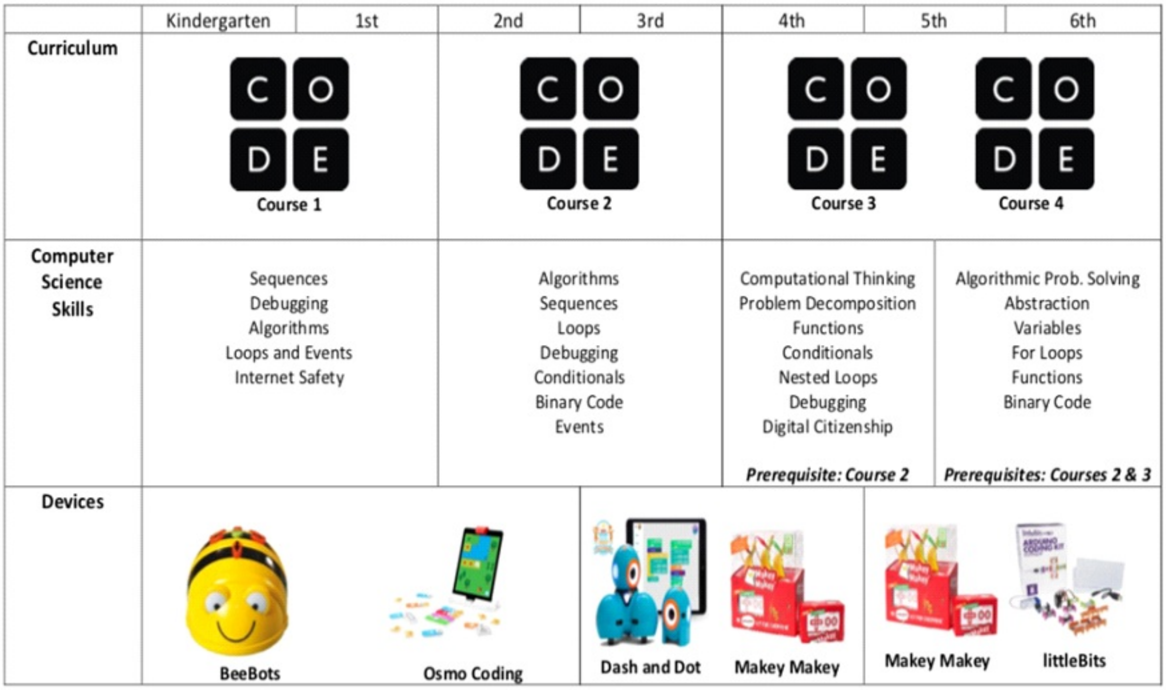

Figure 2. Curriculum map.

per session over 7 weeks. In addition, teachers engaged in professional development to understand the content and design lessons that will support student learning. Teachers had an opportunity to work with a digital media arts teacher to co-teach lessons and to better support the teacher learning the content and curriculum. Fidelity to the program was measured by survey data results and teacher focus group responses. Over the course of 7 weeks, data were collected to determine the effectiveness of the program as described in Chapter 3.

Professional Development and Training

The program provides a series of training and professional development for teachers. The purpose of the training is to develop the concept ideas of what Discovery Labs will be used, in addition to developing teacher knowledge and provide students with an opportunity to learn computer science skills. Table 3 outlines the five areas in which professional development and training was provided to teachers. It provides a chronological look at what the professional development and training looks like for teachers at the elementary school site.

Summary

Although few schools are in the early stages of developing practices that support digital literacy, there is much work to be done. The basis of learning these skills lies in the explicit teaching of computer science and coding. To begin that work, teachers need to be provided with ample support and training to prepare them for this quest. Additionally, schools must create a culture where computer science is not gender specific, rather, it is skill that any gender can and will acquire. The study proposed in the next chapter describes a school that has created a K-6 coding program that includes providing teachers professional development. The intent of this study will examine the program's effectiveness at a K-6 elementary school.

Table 3

Professional Development and Training

Discovery Lab	Lesson
	Introductory
Makerspace	What is Makerspace & Discovery Labs? • Introduction to Makerspace & Discovery Labs • Share the Mission & Vision for the School • Review Scope and Sequence of the labs
Intro to Coding	Code.org • Set-up class accounts • Review lessons within the program • Review resources—videos and lesson plans • Map out grade level courses
Discovery Labs	What are Discovery Labs? • Purpose for the Discovery Labs • School-wide expectations
	Devices
K-2 Lab	Introduction and discovery of devices: • Use of Ipads • Beebots • Osmos
3-4 Lab	Introduction and discovery of devices: • Ipads/Laptop • Dash & Dots • Makey Makey
5-6 Lab	Introduction and discovery of devices: • Laptops • Makey Makey • Little bits
	Teacher development
Lesson Design	Grade Level Development & Exploration • Explore resources related to their grade level devices • Create introductory lessons
Lesson Design (ILT)	Grade Level Cluster Development & Exploration • Instructional Leadership Team develops lessons for grade level clusters to use (K-2, 3-4, and 5-6)

(*table continues*)

Table 3

Continued

Discovery Lab	Lesson
	Thrively
Teacher Training	Grades K-6 Teacher Training • Teachers take the Thrively Assessment to determine strengths • Access and set-up for student use
Teacher Training	Grade Level Cluster Training • K-3 teachers • 4-6 teachers
	Co-teaching
Digital Media Teacher	Grade Level Support • Part-time Digital Media Teacher supports in a co-teaching model to teach coding lessons to teachers and students
Digital Media Teacher	Lesson Design • Digital Media Teacher works with teachers one-on-one and with grade levels to develop and co-teach lessons in the Discovery Labs

CHAPTER 3—METHODOLOGY

This program evaluation examined the implementation and short-term impact of a schools' coding program. As explained previously, the evaluation was conducted at a K-6 elementary school that opened its doors in July of 2017 and is in the beginning stages of implementing the Koi Coding program. The school is one of 46 schools in a large elementary school district located in Southern San Diego. Of the 46 schools in the district, it is the only known school currently implementing the program. To assist in the facilitation of the programs' implementation, the school was designed with three Discovery Labs where computer science coding skills were taught to elementary school children during the instructional day.

The evaluation employed a mixed-methods approach, using both qualitative and quantitative data. Mixed-methods, according to Mertens and Wilson (2012), helps to "clarify the relationship between the two data sets" (p. 461). Quantitative data were collected from both teacher and student surveys, while qualitative data were collected from the teacher focus group and one open-ended student survey question. Program evaluation was the most suitable means for this type of inquiry, since it lends itself to a formative focus on early judgments about this new program, as well as identifying opportunities for program optimization. Data collected from surveys and the focus group helped to determine the effectiveness of the program. The data also assisted the evaluator in determining the impact of teacher preparedness, which was primarily established through professional development. Ultimately, the intent was to provide early indicators regarding efforts to attract school-age girls to the computer science field and create a gender-neutral learning experience for students. Over the course of the 7-week implementation period, survey data were collected from 316 students and 28 teachers. Additionally, focus group data were collected from 7 teachers.

Evaluation Questions

The following questions were used to frame the Koi Coding program evaluation:

1. Is the Koi Coding Program implemented with fidelity, as measured by the program's defined implementation guidelines?
2. Over the course of the evaluation period, what strategies have the teachers learned, through professional development and curriculum implementation, that would play a role in creating a gender-neutral approach to computer science?
3. Has the Koi Coding program, and the professional development component in particular, resulted in mindset changes for participating teachers, including the application of strategies to eliminate cultural stereotypes in computer science? If so, in what ways?
4. What impact, if any, does the implementation of a 7-week coding program have on students' reported career choices and interest in computer sciences?
5. Do student outcomes differ based on the quality of the program's implementation?

Participants

The participants in this program evaluation were selected from a single-school that serves approximately 750 students of which 47% are females and 53% males. Key population demographics include: 14% English learners, 40% Hispanic, 25% socioeconomically disadvantaged, 42% military, and 14% of students receive special education services. The school opened in July 2017 and is in year two of implementing the Koi Coding program. Most students and teachers included in this evaluation either attended or worked at the elementary school for two consecutive school years. Since the program was developed at the school site, it was key for teachers to receive professional development in the 2017-18 school year, as described in Chapter 2, before implementing the computer science coding program. Year one professional development was designed to familiarize teachers with the concept and design of the program and to teach them about computer science and coding. In the 2018-19 school year, the focus was to take the previous years' learning and provide teachers with skills and strategies to create a gender-neutral learning environment for students during their computer science coding instruction. Following each professional development session, teachers began to apply their learning to the Koi Coding program. In the following sections, teacher and student participation criteria will be discussed. It is important to note that neither teachers nor students will be identified in order to maintain confidentiality.

Students

All students in grades third through sixth were invited to participate in this evaluation, provided they met the following inclusion criteria: (a) the classrooms were in a selected school in the Chula Vista Elementary School District; (b) attended the school where the evaluation was conducted; and (c) students were provided with coding lessons in the Discovery Labs over the course of 7 weeks. In all, data were collected from 316 students in the evaluation.

Teachers

All teachers in grades kindergarten through sixth were invited to participate provided they met the following inclusion criteria: (a) they were teachers at the site where the evaluation was conducted; (b) the classrooms were in a selected school in the Chula Vista Elementary School District; (c) their students participated in the coding Discovery Labs; (d) they must have received professional development with the coding devices; and (e) after receiving professional development, teachers provided coding instruction to students. Based on the above criteria, a total of 28 teachers were selected to participate in the evaluation.

Focus Group Teachers

Based on survey results, seven teachers in grades kindergarten through sixth were selected to participate in the focus group. The group of teachers represented kindergarten, first, second, third, fourth, and sixth grades. In addition, one primary special education teacher participated. The teachers were invited to participate based on survey data that indicated they used the program over 7 weeks for at least 2-3 times per week. One teacher from each grade level was selected to provide input and perspective on the program and, in particular, their preparedness to teach coding. Teachers who did not receive the preprogram training were not included in the focus group. In addition, due to not meeting the exclusion criteria, fifth grade was not represented in this group.

Instruments and Procedures

Student Surveys

A total of 316 students who met the inclusion criteria participated in the evaluation's survey component over the course of a 7-week period. Students were given a presurvey to analyze their perception about computer science coding prior to the start of the program. Upon completion of the 7-week course, a postsurvey was administered to analyze their perception of the Koi Coding program. The evaluator compared the pre- and postsurvey data, which will be discussed in detail in Chapter 4. The survey was administered to students during the instructional day and took approximately 10 minutes to complete. Quantitative data measured students' perceptions and opinions of the program in the following key areas: (a) likes and dislikes of the program, and (b) whether students believed the program was valuable to their learning.

The survey included attitudinal measures that employed the following 4-point Likert scale ranging from: (1) strongly disagree; (2) disagree; (3) agree; and (4) strongly agree. Assigned point values were used to calculate means and standard deviations. There was one open-ended question which gave students an opportunity to indicate their future career choices only. Those open-ended responses were hand-coded to detect each students' desire to enter a future career in computer science. Students only indicated the career name and were not asked to elaborate further. Surveys can be found in Appendices A and B.

Teacher Survey

Quantitative data collected included input from 28 teachers in grades kindergarten through sixth, to include one special education teachers. Participants were given a pre-and postsurvey used to record: (a) fidelity to the program; (b) teacher preparedness through professional development; (c) teacher perception and mindset; (d) teaching with a gender-neutral approach; and (e) teacher's perception of student interest in the program. The 38-question surveys measured responses of attitudinal measures on a 4-point Likert scale, from one being *strongly disagree* to four being *strongly agree.* In other areas of the survey, the evaluator again used a 4-point Likert scale: of one *not at all,* two *to some extent,* three *to a moderate extent,* and four *to a large extent.* In order to calculate means and standard deviations, point values were assigned. The presurvey was emailed out to teachers, and they were asked to take the survey on their own time. After 7 weeks, the postsurvey was provided to teachers during a staff meeting to complete. Both surveys took approximately 12 minutes to complete. The survey can be found in Appendix C.

Focus Group

Based on inclusion criteria, seven teachers participated in a focus group. The 45-minute group discussion was designed to share their full experience with the Koi Coding program. Teachers represented kindergarten through fourth grade, sixth grade, and one primary special education. The focus group had a semi-structured protocol and was digitally recorded and transcribed. The focus group occurred after school and allowed an opportunity for teachers to elaboration on the following:

- experiences with learning the program;
- perceptions before and after using the program;
- successes and challenges implementing the program;
- observations of student interest;
- their mindset before and after implementing the Koi Coding program;
- knowledge and comfort level of teaching computer science and coding (pre/post); and
- beliefs about teaching computer science.

Data collected from the focus group were analyzed to determine the effectiveness of the program, teacher perception of the program, and the impact of professional development to improve teacher preparedness. Data were hand-coded, and the evaluator analyzed participant responses for themes and trends. Additional focus group data were collected to assist in guiding next steps for the program and professional development in the future. The focus group questions are provided in Appendix D.

Data Analysis

Student survey data were analyzed for central tendencies and frequency tabulations to determine participant perception and experience. (Note: only students with matched pre- and postsurveys were included the final sample.) An analysis of student results, based on fidelity to the program, level of implementation, and gender, were closely analyzed. An analysis of variance (ANOVA) was conducted to determine whether there were statistically significant differences between boys and girls. Inferential paired *t*-tests were used to compare whether statistical significances occurred between female and male students. A constant comparative method (Bogdan & Biklen, 2007) was used for the student surveys for one open-ended question in both the pre- and postsurveys to determine students' reported career interests in computer science.

Data from the teacher survey were examined for trends and patterns, and program outcomes narrowed in on answering the evaluation questions. To further explore the data, inferential paired *t*-tests were used to compared significant differences from the pre- to postsurvey data. Focus group questions were written after the survey data were collected in order for the evaluator to further investigate on the evaluation question topics. Focus group transcripts were coded for recurring themes using the constant comparative method (Bogdan & Biklen, 2007) and provided specific details on teacher perception and their experience. Teachers provided input on how to further strengthen the program in the future and were asked to discuss their overall experience. Detailed data findings are reported in Chapter 4.

CHAPTER 4—FINDINGS

The purpose of this study was to evaluate the implementation of the Koi Coding program at one school site, within a single school district. The evaluation was designed to examine the level of teacher preparedness and measure the impact of teaching computer science coding to elementary school-age children. The program was evaluated to uncover whether, after receiving professional development, teachers were better equipped to teach coding to students and the impact it had on their mindset. Specifically, teachers were to employ strategies learned to create a gender-neutral approach to their instruction during their computer science coding lessons. Moreover, the program evaluation examined student input through an analysis of pre- and postsurvey data to determine if participation in the program had a direct effect on students' reported career choices and if students' program outcomes differed based on the quality of the program experience.

This chapter presents findings with respect to each evaluation question. Perspectives from both teachers and students will be reported throughout the chapter to provide context of their overall program experience. The findings will be presented first with teacher data, to include focus group conclusions, followed by student data under each evaluation question. The following evaluation questions were used to guide the evaluation.

Evaluation Questions

The following evaluation questions directed this study:

1. Is the Koi Coding Program implemented with fidelity, as measured by the program's defined implementation guidelines?

2. Over the course of the evaluation period, what strategies have the teachers learned, through professional development and curriculum implementation, that would play a role in creating a gender-neutral approach to computer science?
3. Has the Koi Coding program, and the professional development component in particular, resulted in mindset changes for participating teachers, including the application of strategies to eliminate cultural stereotypes in computer science? If so, in what ways?
4. What impact, if any, does the implementation of a 7-week coding program have on students' reported career choices and interest in computer sciences?
5. Do student outcomes differ based on the quality of the program's implementation?

Methodology Overview

This formative program evaluation employed a preexperimental design. The confines included a time boundary of 7 weeks for data collection. The evaluation involved treatment-only groups and did not feature a comparison group. Participants were from a single school site with a total of 316 students and 28 teachers. Data collected measured the overall impact of the program and the effects it had on teachers and students. The mixed-methods inquiry accommodated both quantitative and qualitative data. Both teachers and students were provided with survey instruments, which provided the quantitative data aimed to measure the impact of the program for both groups. Furthermore, qualitative data were collected through a teacher focus group interview and one open-ended student survey question. The focus group was conducted with seven teachers to understand their overall experiences with the program and to guide future program implementation efforts. The combined instruments were designed to understand overall impact of the program for both teachers and students.

Koi Coding Program Fidelity

The Koi Coding program, as mentioned in previous chapters, is a newly designed program at one school site. The program was specifically crafted to meet the needs of both elementary school teachers and students. During the 2017-18 school year, use of the program was not specifically defined; rather, it was a year to explore and learn about the program elements. During this 7-week evaluation period, program guidelines specified fidelity as using the program for 2-3 times per week for a total of 30-45 minutes per session. Survey questions from both teachers and students were gathered and analyzed to determine if fidelity was achieved. Program fidelity and implementation were key in assessing early progress with the schools' program implementation. The following data will uncover if the Koi Coding program was implemented with fidelity, as measured by the program's defined implementation guidelines.

Teachers. Survey questions were provided to teachers to gain an understanding of how many days per week they implemented the program and the amount of time they engaged in each session. A total of 28 teachers responded to the postsurvey. Results showed 25 out of 28, or 89%, of teachers used the program 2 to 3 days per week for at least 35 to 44 minutes, as intended. It is important to note that 22 participants were exposed to preprogram professional development in the 2017-18 school year, while 6 new teachers were added in the 2018-19 school year. Despite these differences in preparation, program utilization was strong. Of the 28 teachers, only three were not using the program as intended. Interestingly, those three teachers were from the same grade level team and were exposed to the preprofessional development. Further implications as to why will be explored in Chapter 5. Table 4 presents a detailed picture of program implementation, specific to fidelity. Current practice, as reported by teachers, was compared against program requirements as shown in Table 4.

Table 4

*Percent of Teachers by Days and Times Fidelity Report (*n *= 28)*

I teach coding . . .	0 days per week	1 day per week	**2 days per week**	**3 days per week**	4 or more days per week
More than 55 minutes	0	3	**0**	**0**	0
45-55 minutes	0	0	**3**	**1**	0
35-44 minutes	0	0	**17**	**3**	0
25-34 minutes	0	0	**0**	**1**	0
Less than 25 minutes	0	0	**0**	**0**	0
Total	0	3	**20**	**5**	0
Percentage of teachers	0%	11%	**71%**	**18%**	0%

Students. Student survey responses were gathered to provide input on the frequency and time with which students used the program in their classrooms. The purpose of analyzing data in this context was to determine if fidelity was met as reported by students. A total of 316 students who responded to this postsurvey question were included in this analysis. Of the 316 responding students in third through sixth grades, 203 or 64% reported they used the program at least 1-2 times per week, 84 or 27% students reported using the program 2-3 times per week, 11 or 4% used the program 4 or more days per week, and 18 or 5% reported not using the program at all.

When compared to the teacher results, student data revealed students were consistently using the program anywhere from 1-3 times per week. As mentioned previously, program fidelity is using the program 2-3 times per week. While 89% of teachers reported using the program 2-3 times per week, only 84 or 27% of the students reported using the program with fidelity. When comparing teacher and student results, the evaluator would have expected to see consistent results in program fidelity; however, the results were inconsistent. A detailed distribution of students' grade level by number of days and total percentage of students by days using the program is shown in Table 5.

Table 5

*Student Days per Week by Grade Level Fidelity Report (*n *= 316) on a 4-Point Likert Scale*

This second year I used the Discovery Labs . . .	Not at all	1-2 days per week	**2-3 days per week**	4 or more days per week
3rd grade	0	37	**31**	1
4th grade	6	59	**15**	2
5th grade	1	42	**26**	3
6th grade	11	65	**12**	5
Total students	18	203	**84**	11
Percentage of students	5%	64%	**27%**	4%

Conclusion. A comparison of data between teachers and students revealed inconsistent reporting regarding program implementation. Of the 28 teachers, 24 (89%) reported using the program with fidelity. Yet, just 27% of all students reported using the program 2-3 times per week. To be consistent with reporting, both teachers and students should have had similar responses indicating they used the program 2-3 times per week. Therefore, fidelity cannot be fully confirmed based on these results. It is evident that most teachers and students used the program, but the reported number of times per week were inconsistent. Observations from the evaluator determined a few barriers: teachers had difficulty scheduling time in the Discovery Labs; finding time in the instructional day to teach coding; and, not feeling prepared to teach coding. An exploration of these barriers is presented in Chapter 5.

Creating a Gender-Neutral Approach to Computer Science

The second evaluation question was designed to uncover the strategies teachers learned through professional development and curriculum implementation that would assist them in creating a gender-neutral approach to teaching computer science. As part of the program, teachers were provided with professional development in two sections over a 2-year period. The first year was to familiarize teachers with the concept and design of the program, and to educate the instructors on computer science and coding. The second section enhanced the previous years' learning and provided teachers with skills and strategies to create a gender-neutral learning environment for students during their computer science coding instruction. Teachers began to apply their learning to the Koi Coding program after receiving professional development.

Data were collected via survey and then were used to create the focus group interview questions at the conclusion of the evaluation period. The focus group helped the evaluator determine whether teachers learned strategies from professional development and curriculum implementation to create a gender-neutral approach to computer science in their classrooms. Responses from teachers and students were compared as outlined in the following sections.

Teachers. Teachers were queried on whether professional development helped them develop strategies and skills to create a gender-neutral learning experience. Postsurvey responses from 28 participants were based on a 4-point Likert scale: (1) strongly disagree; (2) disagree; (3) agree; and (4) strongly agree. Teachers reported professional development learned helped them to create a gender-neutral learning experience with both boys and girls. Table 6 reflects general data relating to professional development. Instructors were asked "The professional development sessions in which I have participated have prepared me to facilitate the teaching of coding with the engineering design process in the discovery labs." Using the previously described 4-point scale, mean ratings were calculated for each item. An average mean score of 3.24 was uncovered. Another statement to which teachers responded was, "Through professional development, I have developed skills/knowledge to teach coding," the mean average score of 3.04 was reported. The evaluator calculated the mean teacher response for each statement to explore if, as a whole, professional development was seen by teachers as support to creating a gender-neutral learning environment. The overall mean average construct was 3.12 as seen in Table 6. Mean averages in Table 6 reveal the professional development statements as they relate to teachers creating a gender-neutral learning environment.

To further explore, the evaluator used an inferential paired *t*-test to compare teacher responses from the pre- to postsurvey. It was found that for five out of seven questions, there were significant differences from disagree to agree ($p < .05$). Table 7 reflects the questions that showed significant changes related to professional development.

Table 6

Teacher Ratings: Professional Development Statements (n = 29) on a 4-Point Likert Scale

Professional development	Mean
All students in my classroom have equal access to coding lessons	3.90
When I teach coding to my students, I use strategies I have learned to engage both boys and girls in the learning process	3.34
I want more professional development so I can learn more about coding with the engineer and design process	2.80
The professional development I received has helped me reflect on the ways my school can increase the use of coding in the Discovery Labs	3.07
When I plan my lessons, I ensure that I strategically partner students to create a gender balance learning experience	2.90
The professional development that I have received has helped me feel more confident to teach coding to my students	2.68
Through professional development, I have developed skills/knowledge to teach coding	3.04
The professional development sessions in which I have participated have prepared me to facilitate the teaching of coding with the engineering design process in the discovery labs	3.24
Overall score	**3.12**

To further explore this topic, teachers were asked to respond to a series of statements to help determine if they were using strategies and skills to create a gender-neutral learning experience. Teachers reported implementing strategies learned to include both boys and girls in a gender-neutral learning experience. Specifically, instructors were asked to rate themselves on “When I teach coding to my students, I use strategies learned to engage both boys and girls in the learning process.” The overall mean average score construct was 3.34 (Table 8). Overall, teachers strongly indicated

Table 7

Significant Differences T-*Test: Professional Development Statements (*n *= 29)*

Professional development	Pre mean	*SD*	Post mean	*SD*	Sig
I want more professional development so I can learn more about coding with the engineer and design process	3.12	0.52	2.80	0.65	.05
Through professional development, I have developed skills/knowledge to teach the engineering design process	3.32	0.48	3.04	0.73	.05
The professional development that I have received has helped me feel more confident in teaching coding to my students	3.08	0.57	2.68	0.80	.05
Through professional development, I have developed skills/knowledge to teach coding	3.12	0.44	2.84	0.69	.05
The professional development sessions in which I have participated have prepared me to facilitate the teaching of coding with the engineering design process in the discovery labs	3.64	0.49	3.24	0.78	.05

Table 8

*Teacher Ratings: Gender-Neutral Learning Environment (*n *= 29) on a 4-Point Likert Scale*

Gender-neutral learning environment	Mean
All students in my classroom have equal access to coding lessons	3.90
When I teach coding to my students, I use strategies I have learned to engage both boys and girls in the learning process	3.34
When I plan my lessons, I ensure that I strategically partner students to create a gender balanced learning experience	2.90
I find that the gender of my students determines the interest in coding lessons	1.59
I find that girls do better with coding lessons than boys	1.41
I find that boys do better with coding lessons than girls	1.41

that during coding they use strategies learned to engage both genders in the learning process.

Another statement presented was, “When I plan my lessons, I ensure that I strategically partner students to create a gender balanced learning experience.” The mean average score of 2.90 was reported by teachers. Though the mean average score was below a three on a 4-point Likert scale, it demonstrates that some teachers are using this strategy. As mentioned previously, this program is in the developmental stages, and development of these strategies will need to be further explored. Mean averages in Table 8 reveal the teachers’ perception on creating a gender-neutral learning environment. It should be noted that the analysis of these survey responses provided context for the evaluator in the development of focus group questions to further explore this topic.

Focus group questions were developed based on the preliminary survey findings to further explore the teachers’ perspectives about using the Koi Coding program. Teachers had an opportunity to elaborate on their professional development experience. The evaluator used the focus group to gain further insight how professional development had an impact on their teaching. Specifically, questions were posed to understand the impact professional development had on creating a gender-neutral learning environment.

The seven focus group participants were queried about the specific strategies they learned. An analysis of responses revealed multiple teachers described the grouping of students as a primary strategy for creating a gender-neutral experience. Two of the seven teachers reported grouping students by gender to boost female confidence levels. Furthermore, a teacher pointed out, “I make sure that everything is balanced, and each group has equal representation of both genders.” Teachers discussed the challenge of applying the strategies in the special education classroom. One teacher explained how the ratio of boys to girls may not be equal due to the way students are placed in the special education programs:

> For me, I only have one girl and the rest are boys. The one girl is in transitional kindergarten. What I observed was pretty great. When we used Tangrams, I paired her with a kindergarten boy. He did not know how to do something, and it was really neat to see how she figured out the Tangram picture before him. He kind of looked at her like, "What? What did you just do?"

During this portion of the discussion, three of the seven teachers did not respond to this question. Of the seven teachers, three grouped students homogeneously and heterogeneously. A response from one teacher indicated that she homogeneously grouped girls together, which resulted in more participation from her students. That same teacher also shared that when she observed girls working in small groups, it resulted in a more collaborative atmosphere. In fact, the teacher reported that she created an all-girls group "to dissuade the perception that boys always think they are better in science and technology. It's just amazing to see when girls work together!" Another teacher described the experience as, "I just have to think about the grouping in my classroom and make sure everything is balanced to have equal representation of both genders." As reported, teachers purposely grouped students to create a gender-neutral learning environment. During instruction, teachers strategically partnered their students to create a gender balance in their classrooms. Over the course of the evaluation period, four teachers applied instructional strategies to create a gender-neutral, computer science learning experience for students.

The second theme observed was the possibility that female students may not see a gender gap because the ratio of female to male teachers is greater in elementary school. A teacher described that there seems to be more female teachers in elementary school than in middle and high school. The same teacher further explained that “students probably do not see a gender difference because teachers are more women and we’re teaching them how to do it [code].” It could be perceived from this statement that students are not seeing a difference in gender when learning. Later in the conversation, teachers in the focus group agreed that students in elementary school may not see a difference in gender because so many of the teachers at this elementary school site are female. Survey results and data from the focus group discussion suggest teachers are more aware of their students’ gender when designing lessons. Particularly, it was mentioned participants had to be purposeful with lesson planning and creating learning groups to ensure the experience for their students was gender-neutral. It is possible that because of this awareness, teachers use strategies learned to ensure their computer science lessons are gender-neutral.

Students. Student survey results were analyzed to gain insight on their coding experience in a gender-neutral environment. A sample size of 316 students in third through sixth grade responded to statements related to this section. Only 308 students with matched pre- and postsurvey results were included in these data. Results were examined to determine whether boys and girls like to code. Students were asked to respond to a series of questions relating to their coding experiences. Responses were rated on a 4-point Likert scale: (1) strongly disagree; (2) disagree; (3) agree; and (4) strongly agree. Survey responses highlighted students’ perceptions on the importance of learning computer science coding. Data suggest that students felt school was fun because they learn to code in the Discovery Labs. Additionally, it was noted that the participants were excited to learn about computer science coding. When asked if teachers helped them learn to code, overall students responded with a high mean rate of 3.17 in the postsurvey as shown in Table 9.

The evaluator sought to understand if student perceptions of the program differed based on gender. While teachers provided a Koi Coding experience that was essentially equal based on gender, female mean scores were slightly higher, relative to males. Table 9 presents this gender-based comparison of mean ratings. Though the questions did not fully ask students about gender, one statement did ask students to reflect on whether boys and girls like to code. There was not a significant difference between pre- and postsurvey responses, but those questions did yield high mean response rates of 3.21 for boys and 3.26 for girls.

To further explore these findings, the evaluator used an inferential paired *t*-test to compare pre- to postsurvey data from both boys and girls to understand if there were significant differences in their ratings. A presurvey analysis established there were no significant differences with these statements; meaning, when grouped by gender the mean scores at the program start were equal. However, postsurvey data indicated there was a significant difference with the question "I enjoyed learning in the Discovery Lab." The average mean for boys was 3.31 with a standard deviation of .823, while the average mean for girls was 3.49 with a standard deviation of .590. High mean results from both boys and girls may be attributed to the program based on these outcomes.

Table 9

Student Learning by Gender Pre- to Postsurvey Results on a 4-Point Likert Scale

	Full sample (n = 308)		Boys (n = 161)			Girls (n = 147)			
Statements	Pre mean	Post mean	Pre mean	Post mean	*SD*	Pre mean	Post mean	*SD*	Sig
I enjoyed learning in the Discovery Lab	3.41	3.39	3.39	3.31	.823	3.42	3.49	.590	.01
Boys and girls in my class like to code	3.27	3.23	3.28	3.21	.567	3.28	3.26	.525	ns
Learning computer science coding is important to me	3.16	3.00	3.17	3.01	.933	3.15	2.99	.788	ns
School is fun because I learned to code in the Discovery Labs	3.23	3.04	3.00	3.06	.892	3.22	3.04	.846	ns
I am excited because I have learned about computer science coding	3.34	3.09	3.17	3.07	.830	3.33	3.12	.856	ns
Learning to code is easy	2.72	2.76	2.67	2.76	.954	2.75	2.75	.810	ns
My teacher helped me learn to code in the Discover Lab	3.32	3.17	3.26	3.02	.866	3.37	3.35	.670	.001
Coding helps me learn in other subjects (math, science, language arts, etc.)	3.01	2.69	2.50	2.63	.915	3.06	2.78	.920	ns
I will be a better coder because I used the Discovery Lab 3 times per week	3.08	2.67	3.08	2.65	.951	3.08	2.71	.848	ns

Students were asked to rate their experience in response to the statement "My teacher helped me learn to code in the Discover Lab," and a significant difference between boys and girls was uncovered. While postsurvey results from the boys indicated a 3.02 mean average (*SD* = .866), girls were slightly higher with a 3.35 mean average (*SD* = .670) with a difference in mean of 0.33. These data demonstrate that, overall, girls felt they were helped slightly more by teachers, relative to responses reported by boys. This may indicate teachers being intentional as they assist girls with a greater frequency. Table 9 presents student survey questions with mean scores to include whether or not there were significant differences. The data in Table 9 suggest, overall, the students' learning experiences reflected the program may have had a positive impact on learning to code in a gender-neutral environment.

Conclusion. In summary, teacher data demonstrate that strategies learned in professional development impacted their instructional planning to create a gender-neutral environment. The focus group data strengthened survey findings, by describing how the strategies learned though professional development made teachers more aware of creating a learning experience that is gender-neutral. Additionally, student data suggest that teachers are creating a learning experience that resulted in high mean scores for both girls and boys, as described above.

Teacher Mindset and Eliminating Cultural Stereotypes in Computer Science

The third evaluation question explored whether participating teachers, after professional development, experienced a change in mindset to include the application of strategies to eliminate cultural stereotypes. The Koi Coding program aimed to provide teachers with strategies to eliminate cultural stereotypes in computer science. As mentioned in Chapter 1, if computer science is taught at an elementary school level, it may help reduce or eliminate gender and cultural stereotypes and in turn increase the likelihood of students, specifically females, entering the computer science field. The long-term program goal would ultimately be to eliminate gender and cultural stereotypes altogether. The evaluator sought to explore this evaluation question to understand the impact professional development had on teachers resulting in a change in mindset and the application of strategies to eliminate cultural stereotypes.

Teachers. Teachers were asked to indicate the extent to which the professional development resulted in mindset changes after learning specific strategies to eliminate cultural stereotypes in computer science instruction. Statements in this section of the survey sought to understand if strategies learned through professional development had an overall impact on their teaching to include mindset. Though fixed versus growth mindset was discussed in Chapter 2, it is important to review the concept and its relationship to this evaluation question. In summary, teachers with a growth mindset or openness to learning and teaching have a direct effect on student learning and academic outcome. If teachers are not open to learning or teaching new concepts or have a fixed mindset about computer science, this may negatively affect student learning outcomes.

The pre- and postsurvey teacher statements aligned to professional development, and their perceptions of teaching coding that affected their mindset, were rated on a 4-point Likert scale: (1) strongly disagree; (2) disagree; (3) agree; and (4) strongly agree. Table 10 illustrates teacher survey statements with mean scores and standard deviations. When asked to rate themselves on "I have a growth mindset about teaching coding to my students," the mean teacher response was 3.43 of strongly agree. The data in Table 10 reflect that professional development strategies learned resulted in mindset changes. The first two questions were compared using an inferential *t*-test from the pre- to postsurvey, and it was found both questions significantly increased from disagree to agree ($p < .01$). The remaining questions with respect to teacher mindset did not change significantly. Based on teacher survey data listed in Table 10, the evaluator sought to further explore the impact professional development had on teacher mindset through a focus group discussion.

Table 10

*Teacher Survey Mindset Data (*n *= 29) on a 4-Point Likert Scale*

Mindset statements	Pre mean	*SD*	Post mean	*SD*	sig
My confidence level in teaching coding has increased because of the professional development I have received	3.12	0.73	2.64	0.64	.01
Developing skills to teaching coding has affected my mindset in a positive way	3.24	0.66	2.88	0.73	.01
My level of confidence to teach coding affects my mindset	2.92	0.81	2.56	0.87	ns
I enjoy learning how to code	3.20	0.76	3.08	0.70	ns
I enjoy teaching students to code	3.24	0.66	3.00	0.76	ns
I have a growth mindset about teaching coding to my students	3.66	0.54	3.43	0.62	ns

Focus group interaction was used to further understand these survey findings. This aspect of the protocol challenged teachers to describe the impact professional development had on their mindsets when teaching coding. Response data were collected, coded, and reviewed. The evaluator closely examined participant responses to identify if there were shifts in teacher mindset. It was found that five of the seven teachers said they felt overwhelmed before receiving professional development. Participants shared that teaching students to code was a new concept and was unfamiliar, thus causing some uneasiness. During the conversation, four teachers said that after receiving professional development, they found themselves more exited and eager to learn something new. In fact, one teacher disclosed:

> I was eager to learn and to know how I was going to be able to implement it. Once we started getting professional development, it was overwhelming because I really did not know what I was learning. I was nervous. I didn't know where to begin, but now I feel excited. I really want to teach coding. Nowadays, for me, it's just really positive.

Two teachers said that as they develop their skills and knowledge on how to teach computer science coding, and over the 7 weeks they had a shift in mindset to teach computer science. Particularly, one teacher stated:

> Definitely affected my mindset. It just got me looking at the implementation of coding into the curriculum in a different way. I initially thought that it was nearly impossible and here we go. Something totally new, something else on my plate. When so much of the coding, problem solving, and the collaboration aspects can really be tied into other content areas very easily now after having those professional developments.

Another teacher discussed his experience with the program and the effects professional development had on him as a teacher:

> I think having some of the hands-on professional development was super beneficial. I was, like, we are actually trying these things out [coding devices] and

> that was super beneficial, because then it was like we are actually learning it. I think the PD [professional development] totally helped and made me feel like, okay, I can do this.

Throughout the focus group discussion, teachers described: (a) they felt overwhelmed; (b) learning something new was exciting; and (c) having a growth mindset matters. Overall, it was confirmed through the discussion that learning to teach coding impacted the teachers' mindset. One teacher noted, "Once we started getting professional development, it was overwhelming. So, for me it's really positive nowadays compared to the beginning." Though teacher mindset was discussed in the focus group, the evaluator further explored by analyzing student survey data.

Students. Student survey results were analyzed to gain insight on gender and cultural stereotype gaps. As mentioned previously, the long-term goal of the program would be to eliminate the gaps. The evaluator used student data as measures to understand if the program made an impact on both boys and girls over a 7-week period. A total sample size of 316 students in third through sixth grade responded to questions related to computer science coding and their future. A total of 308 students with matched pre- and postsurvey results were included in these data. Responses were disaggregated by pre- to postsurveys and by gender. Responses were rated on a 4-point Likert scale: (1) strongly disagree; (2) disagree; 3 (agree); and (4) strongly agree. Results were analyzed to determine if the mean averages increased from pre- to postsurveys to demonstrate the likelihood of students entering a computer science field in the future regardless of their gender. Table 11 displays survey results indicating that the average mean scores for both boys and girls increased. An inferential paired *t*-test was conducted to measure if significant differences occurred between genders. No significant differences occurred. Data in Table 11 reveals that boys had an increase of pre- to postmean scores of 2.70 to 2.83, and girls also had an increase of 2.54 to 2.64. These results could mean it is likely the program may have had an impact on reducing stereotypes over the course of 7 weeks.

Table 11

Pre- to Poststudent Survey Results to Eliminate Stereotypes on a 4-Point Likert Scale

	Full sample (n = 308)		Boys (n = 161)		Girls (n = 147)		
Question	Pre mean	Post mean	Pre mean	Post mean	Pre mean	Post mean	Sig
I hope that my future career will be in computer science so I can use my coding skills	2.41	2.58	2.52	2.62	2.27	2.42	ns
I will be good at coding and computer science	2.94	3.02	2.98	3.06	2.89	2.97	ns
I would like to be a coder or be in the computer science field someday	2.23	2.47	2.34	2.62	2.09	2.24	ns
Learning to code is important to my future	2.93	3.01	2.96	3.03	2.90	2.94	ns
Average total	**2.62**	**2.77**	**2.70**	**2.83**	**2.54**	**2.64**	

Conclusion. Based on the data aligned to the evaluation question, it is likely that professional development had an impact on teacher mindset as measured by survey and focus group results. Focus group participants shared their learning experiences, which provided more insight into the survey data. Teachers employed strategies to create a gender balanced, gender-neutral learning environment to eliminate cultural stereotypes. Though confidence mean scores appeared to be lower than the actual act of learning to teach coding, results may be used to drive next steps for the program. In addition, student results showed that over a 7-week period, overall means increased. This may or may not be attributed to the program.

Students Reported Career Interest in Computer Science

The fourth evaluation question sought to discover if the 7-week coding program had an impact on students' reported career choices and interests' in computer science. The Koi Coding program had several overarching goals to accomplish, some of which were not analyzed in this program evaluation. Among those not evaluated in this study were the long-term goals of the program to close the gender gap that exists in higher education and in the workforce. One larger program goal, which was assessed in this formative evaluation, was students' interest in a future computer science career.

Students. The pre- and poststudent surveys assessed the potential of boys and girls having an interest in computer science. Responses were based on attitudinal measures on a 4-point Likert scale: (1) strongly disagree; (2) disagree; (3) agree; and (4) strongly agree. A total of 316 students were included in these data. A total of 308 students with match pre- to postsurvey data were included in the findings. The presurvey responses found more boys hoped to have a career in computer science, while fewer girls had an interest. A comparison of postsurvey data found that girls had an increase in means from pre- to postsurvey data of 1.67 to 2.27, as shown in Table 12. An inferential paired *t*-test was conducted and found there were no statistically significant differences for boys or girls from the pre- to posttest with the question, "I hope that my future career will be in computer science, so I can use my coding skills." Overall, means increased for both boys and girls over the evaluation period.

Table 12

Pre- to Postsurvey Data: Future Career in Computer Science on a 4-Point Likert Scale

	Boys (*n* = 161)				Girls (*n* = 147)				
	Presurvey		Postsurvey		Presurvey		Postsurvey		
Question	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Sig
I hope that my future career will be in computer science, so I can use my coding skills	2.14	0.99	2.52	0.97	1.67	0.47	2.27	0.90	ns

The student survey did pose one open-ended question to gain insight on whether their program experience influenced future career choices. Here, students provided a constructed response to the prompt, "when I grow-up I want to be" and inserted a future career choice. A measure of central tendencies was conducted. Responses were collected to provide the evaluator with a snapshot of generally what careers students selected before and after the 7-week program implementation. Since this was an open-ended question, the evaluator hand-coded the responses identifying computer science career choices. Figure 3 reports the pre- to postsurvey percentages of students who reported a career choice in computer science. The presurvey indicated that 25% of both boys and girls selected a career in computer science. When broken down by gender, 20% represented boys, while 5% represented girls. After a 7-week implementation period, 36% of students reported a career choice in computer science, which is an increase of 11%. When broken down by gender, boys increased by 5%, while girls increased by 6%. During the evaluation, a setback was encountered with identifying whether the increase in percentages were from the same students. Though Figure 3 represents survey results by gender and there was an increase reported career choices, it is unknown if the students were the same students from pre- to postsurveys.

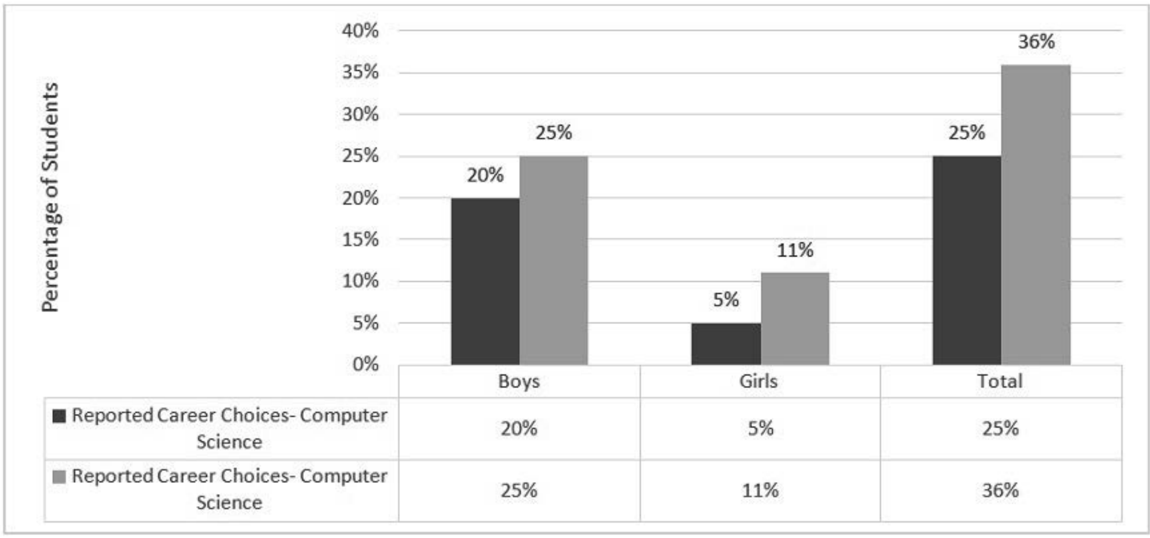

Figure 3. Pre-to postsurvey data: Reported career choices in computer science (n = 308).

Conclusion. Though it cannot be confirmed that the same students, the data presented in Figure 3 do show an overall increase in reported career choices during the seven-week evaluation period. It is important to point out that girls, generally, had slightly lower reported career choice percentages. However, with survey data girls had a higher mean score of hopes to have a future career in computer science. Overall, results increased positively in students reporting future career choices in the computer science field.

Quality of the Program

Evaluation question 5, examined if student survey outcomes differed based on the quality of the program implementation. Students in third through sixth grade engaged in the Koi Coding program at varying levels of implementation. Student survey data closely examined 316 students to gain insight on students' perception of the program. Of the 316 students, 18 indicated that they did *not at all* use the program; therefore, they were not included in these data. Student survey responses were compared based on the amount of time students used the program. Responses were based on attitudinal measures on a 4-point Likert scale: (1) strongly disagree; (2) disagree; (3) agree; and (4) strongly agree. Three comparison groups were established based on implementation: (a) 1-2 days per week; (b) 2-3 days per week; and (c) 4 or more days per week. Students who reported they "did not use the program at all" were not included in this analysis. Student data indicated a high mean of 3.21 for using the program 2-3 times per week. Additionally, students reported a high mean of 3.11 for using the program 4 or more days. The evaluator compared results focused on students using the program by the number of days and by the questions that sought to understand students' perception and experience with using the program. Students using the program for 2-3 days per week, on average, had a higher reported mean score than those using the program 1-2 days and 4 or more days. Table 13 is based on a total of 298 students with reported data.

An analysis of variance (ANOVA) was conducted using the data displayed in Table 13 to determine whether there were statistically significant differences between boys and girls. Statistically significant differences were largely absent among the two groups. However, there was a statistically significant difference with the question "Coding will help me learn in other subjects (math, science, language arts, art, etc.)" depending on the number of days students report using the program the previous year ($p < .05$). A paired t-test analysis showed that the response from students who reported using the program an average of 2.92 for 1-2 days a week ($SD = .883$) was significantly

Table 13

Poststudent Data by Days and Questions on a 4-Point Likert Scale

	Days per week						
	1-2 days/week (*n* = 202)		2-3 days/week (*n* = 85)		4 or more days/week (*n* = 11)		
Question	Mean	*SD*	Mean	*SD*	Mean	*SD*	Sig
I enjoyed learning in the Discovery Lab	3.41	0.71	3.54	0.65	3.22	0.92	ns
Boys and girls in my class like to code	3.27	0.49	3.18	0.60	2.88	0.78	ns
Learning computer science coding is important to me	2.94	0.88	3.07	0.76	3.56	0.96	ns
School is fun because I learned to code in the Discovery Labs	3.10	0.87	3.24	0.81	3.22	0.92	ns
I am excited because I have learned about computer science coding	3.13	0.80	3.22	0.84	3.11	0.99	ns
Learning to code is easy	2.80	0.92	2.72	0.89	2.89	1.10	ns
My teacher helped me learn to code in the Discover Lab	3.14	0.82	3.24	0.82	3.11	1.10	ns
What I've learned about coding helps me learn in other subjects (math, science, language arts, etc.)	2.59	0.97	2.85	0.90	2.67	1.33	ns
I will be a better coder because I used the Discovery Lab 3 times per week	2.81	0.98	3.21	0.78	3.11	0.87	ns

different from those who reported using it an average of 3.26 for 2-3 days per week (*SD* = .756). This valuable information shows that students who use the program as intended, 2-3 days per week, had greater perceived outcomes than those who used it 1-2 days and 4 or more days.

A mean of all mean scores listed in Table 13 were calculated to compare the averages of the responses across the amount days using the program. Students who used the program 2-3 times per week had a highest average mean score of 3.12, relative to students in the other two groups. This suggests that students who used the program, as intended, provided higher ratings in terms of their interests and self-assessed abilities specific to coding. Students who used the program more than intended had an average mean of 3.09, while students who had fewer sessions per week had the lowest average mean score 3.02. Figure 4 illustrates these outcomes.

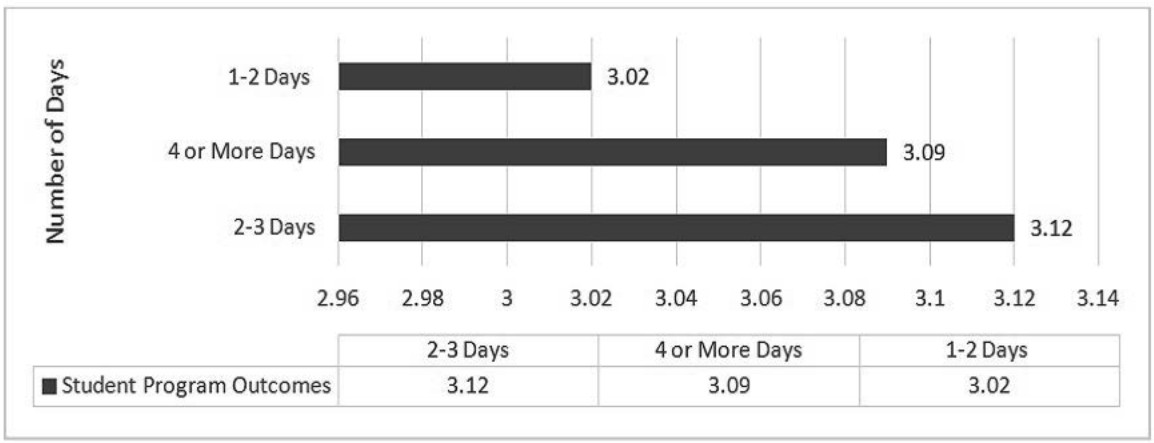

Figure 4. Student mean of all mean scores on overall experience with using the program (n = 308).

Student surveys results differed based on the number of days per week students used the program. Using the program more or less did not increase students' interest and their general learning experience. Students who used the program 2-3 times per week, as intended, did result in a higher mean overall.

Summary

Quantitative and qualitative data collection methods, aligned to the evaluation questions, were used to measure the program implementation and outcomes. Data analysis revealed consistencies across the full complement of data. Teachers reported that they felt more prepared to teach computer science coding after receiving professional development, which they believed had improved their knowledge in that area. In addition, there were consistent data reports indicating that teachers learned strategies and skills to help create a gender-neutral learning experience for students. Student responses suggested that the when using the program 2-3 times per week, as intended, the higher standard mean scores than those using is 1-2 days or 4 or more days. After 7 weeks of using the Koi Coding program, student career choices in the computer science field increased. Data collected had a perceived outcome that the program had an impact on both teachers and students.

Chapter 5 provides a restatement of the problem, key findings, limitations and recommendations of the evaluation, implications for school and program leaders, and recommendations for future evaluation of this program.

CHAPTER 5—SUMMARY, DISCUSSION, AND CONCLUSION

The purpose of this formative program evaluation was to study the implementation and the effects of the Koi Coding program. The program was designed to help prepare elementary school teachers to create a gender-neutral approach to computer science. This program evaluation examined the impact professional development had on teachers to make them more aware of creating a gender-neutral learning environment to ultimately eliminate cultural stereotypes for the students at one elementary school. This chapter provides a brief description of the program, intended outcomes, and a discussion of the program evaluation. An interpretation of the findings, connections to the findings, and recommendations for improvement are also included. The chapter concludes with limitations of the study, implications for school leaders, and implications for future evaluation of this program,

The discussion in this chapter was guided by five questions and provided an avenue to evaluate the program, while providing data that would assist the school in determining next steps. Since the program is in the beginning stages of development and was launched in the 2018-19 school year, it was essential to the capture the efforts thus far. The evaluation questions and the work that was conducted during the 7-week period provided context to understand the program's implementation formatively and early indicators about whether the program made an impact on both teachers and students.

Interpretation of the Findings

Gaining the perspective of teachers and students was key to evaluating the Koi Coding program. Teachers utilized skills and strategies learned through professional development to provide a gender-neutral approach to teaching. The intent was to gain students' interest in computer science coding, in particular the interest of females. The findings provided a glimpse into a newly designed coding program and, therefore, are largely formative in nature. An analysis of the results offers insight for next steps with the program in terms of preparing teachers by means of professional development. There are five themes that will drive the discussion to provide insight as it relates to each evaluation question: (a) program fidelity; (b) gender-neutral approach to teaching computer science; (c) changing teacher mindset and eliminating cultural stereotypes; (d) student's reported career interests in computer science; and (e) quality of the program. The following discussions, which address each theme, contain perspectives from both teachers and students who used the program during the evaluation period. A summary of each theme, to include a detailed discussion, is described in the following sections by evaluation questions.

Evaluation Question 1

Is the Koi Coding program implemented with fidelity, as measured by the program's defined implementation guidelines?

The description for using the Koi Coding program with fidelity would require teachers and students to use the program 2-3 times per week for a period of 30-45 minutes. Through the findings, it was determined that both teachers and students used the program. It was found that the program was implemented with a moderate level of fidelity, as stated in the implementation guidelines. The questions in each survey solicited responses from both teachers and students to estimate the frequency and time using the program over the 7-week period. The evaluator found that teacher and student survey data did not match up. Meaning, program fidelity indicated that teachers and students used the Discover Labs 2-3 times per week. Teacher and student survey questions were not fully aligned. Teachers were asked to share the number of days per week they used the lab, and students were asked based on a cluster of days. Both questions should have been fully aligned by matching the number of sessions per week. Overall, there was program use, but the evaluator was unable to fully confirm fidelity due to the inconsistent manner in which the questions were asked. In order to compare the results, the evaluator compiled the teacher data to match the student data, as mentioned in Chapter 4. The evaluator found that the program was being used, and sessions were generally 30-45 minutes long, as defined in the guidelines. These differences in reported use were vital in determining whether using the program with fidelity had an impact on student and teacher outcomes in the surveys and focus group.

The evaluator further explored fidelity through the focus group discussion, specifically why some use the program more than others. Participants in the focus group were able to elaborate on their program use. Teachers shared that the more professional development they received, the more they used the program. This could possibly be a result of increased teacher comfort levels specific to teaching computer science coding. Focus group participants who took part in the preprogram professional development indicated that this training was valuable for their learning and comfort level with teaching coding. Overall, focus group participants shared that the more comfortable they felt teaching computer science, the more they used the program.

The program guidelines were specific with the duration and the frequency of time each participant was to use the program. When these expectations were not met, it was due to a number of identified barriers. Participants expressed that scheduling time to use the Discovery Labs was difficult. Grade level clusters shared the labs and, oftentimes, teachers had difficulty finding a time slot that worked with their schedule. Teachers felt at times that they had to "give something up" in their instructional day to meet the program fidelity criteria. A consideration for future program improvement would be to develop a more comprehensive set of guidelines to allow some flexibility in the location where the lessons are being delivered, perhaps allowing teachers to use both classrooms and Discovery Labs. Devices used in the labs could be moved around from one location to another to accommodate flexibility in the schedule.

As with any program, teacher input is vital to the success of this new program. These evaluation results describe the teachers' experience implementing the program. Overall, the program was being implemented at the school site. Access to the program occurs at various times in the instructional week. As mentioned previously, this evaluation will serve as a guide to refine future program expectations to maximize teaching and learning computer science coding.

Evaluation Question 2

Over the course of the evaluation period, what strategies have the teacher's learned, through professional development and curriculum implementation, that would play a role in creating a gender-neutral approach to computer science?

The evaluation confirms that after receiving professional development, teachers implemented strategies which helped to create a gender-neutral learning experience for students. It was evident throughout the evaluation period that teachers appreciated and utilized the skills learned from professional development to create a gender-neutral approach to teaching computer science. The professional development sessions concentrated on teachers understanding the purpose and goals of the program. The later sessions introduced teachers to strategies, such as: (a) student grouping; (b) coding device exploration; and (c) support the idea of creating a gender-neutral approach to teaching computer science. Data gathered from the focus group suggested that prior to receiving professional development, teachers did not necessarily focus on creating a gender-neutral classroom. After receiving professional development, and implementing newly learned teaching strategies, teachers explicitly planned lessons with gender in mind. Teachers became more aware of gender inequities and focused on strategically grouping students to boost student confidence to create an environment that is gender inclusive. One teacher stated that professional development "had me thinking about the grouping and the grouping in my classroom. I make sure that everything is balanced and have equal representation of both genders." Throughout the course of the evaluation, teachers employed teaching strategies that were learned in professional development sessions. One such strategy was grouping students heterogeneously and homogeneously. Teachers created various gender learning groups and gathered formative data to see what impact the data had on student learning. Teachers found that when girls were grouped together, their participation increased. When teachers formulated mixed gender groups, teachers reported that, at times, boys would dominate the group.

Participating teachers revealed that at the end of the 7-week program, they utilized the strategy of strategically placing students to create a gender balanced learning experience. Teachers created lessons to ensure strategic planning of engaging both boys and girls in the learning process was conducted. Students confirmed that their learning experiences were enjoyable, important, and supported their learning in other content areas. This evaluation established that teachers are providing both girls and boys with equal access to the coding program.

Though the evaluation confirmed that an attempt to eliminate gender stereotypes was made, it is important to note gender gaps do exist to a great extent in the computer science field. The literature review in Chapter 2 highlighted the fact that gender gaps in STEM and computer science present a significant problem in the educational system and job field in America. Master and colleagues (2016) conducted research and found that girls, when compared to boys, feel a loss sense of belonging in the computer science field due to stereotypes. In fact, their research specifically pointed out that stereotypes have a direct effect on the reduction of female presence in computer science. This research demonstrates the need for teachers to continue to develop skills that would support the elimination of gender gaps. This includes creating more gender-neutral learning experiences for students. In addition, the research of Hsu and colleagues (2011) indicated there is an

> urgent need for researched-based teacher professional development, we know little about elementary school teachers' perception to teach design, engineering, and technology (DET), their motivations to teach DET, and possible differences based on demographic factors such as gender, ethnicity, and teaching experience. (p. 32).

It was uncovered that the perception of both boys and girls demonstrated that the teachers did, in fact, create learning environments that were gender inclusive.

Considerations would include ensuring that teachers continue to plan lessons that would create a gender-balanced learning environment for students, and employing the strategies learned through professional development to engage all learners. Another consideration would be to continue to provide professional development for teachers as the program develops to provide additional strategies that would aide in creating a gender-neutral approach to teaching computer science coding.

Evaluation Question 3

Has the Koi Coding program, and the professional development component in particular, resulted in mindset changes for participating teachers, including the application of strategies to eliminate cultural stereotypes in computer science? If so, in what ways?

Prior to the program delivery, it was known that learning new strategies would require teachers to participate in professional development, which may or may not also result in shifts in mindset. The Koi Coding program aimed to provide participating teachers with support in creating a growth mindset. Focus group results demonstrate that the participating teachers had a shift in mindset after receiving professional development. Generally, teachers enjoyed learning to code and enjoyed teaching students to code. However, focus group participants shared they had more of a fixed mindset when they first started to learn the new content. After receiving professional development and after practicing what they learned, focus group participants shared their mindset shifted more to a growth mindset. As teachers developed their skills, it was reported that not only did their mindset positivity change, their confidence also improved. Learning new strategies and a new program proved to be beneficial to support teachers in creating a growth mindset.

In the focus group, teachers had a rich discussion about professional development and the effect it had on their mindset to teach coding. Their professional development sessions included a hands-on exploratory experience where tinkering with coding devices was a way of learning. It decreased teacher anxiety and increased their curiosity to want to learn more. In turn, teachers used that same method to teach their students, knowing that it was a risk-free environment, with no room for mistakes. They employed problem solving strategies and encouraged exploration, innovation, and creativity. Teachers who participated in the program, and who received professional development during the course of the evaluation, decreased the chances of creating gender stereotypes in their classrooms. Teachers agreed that their new learning made them more aware of gender participation in their computer science lessons.

Research has shown that cultural stereotypes can be eliminated when barriers are not created. An analysis of this program data implies that within a short period of time, utilizing professional development strategies helps make educators more aware of the grouping of students. In addition, the instructors created lessons that allowed for students to explore in a risk-free environment, thus creating an equal playing field for learning. The research of Master and Meltzoff (2016) reported that cultural stereotypes exist when children begin to internalize their beliefs that they do not belong, such as in the STEM field. The evaluation explored the impact of professional development and the effect it had on gender stereotypes. Quinn and Cooc (2015) conducted research which affirms that gender gaps play a significant role for the lack of social equity in computer science. Teacher preparedness in this evaluation specifically focused on eliminating such stereotypes. It is fair to assume that during this evaluation period, the program experience excluded cultural or gender stereotypes and created a generally positive experience for both teachers and students.

Evaluation Question 4

What impact, if any, does the implementation of a 7-week coding program have on students' reported career choices and interest in computer sciences?

The implementation of a 7-week Koi Coding program aimed to teach students to code to become digitally literate. While the program evaluation was conducted over just a few weeks, it was evident that students expressed a high interest in the program. The intent of the program was to offer students an opportunity to learn computer science through coding. Since it is known that cultural and gender stereotypes begin in adolescence, the program was provided to students as young as 5 years of age. Instruction was provided to all students in kindergarten through sixth grade, but the surveys were only given to students in third through sixth grade. Participating focus group teachers communicated that the interest level in all participating grade levels was high. Their perception was that students were highly engaged and enjoyed the program. Participants also noted that they implemented strategies learned through professional development to create a learning environment free from gender stereotypes.

Within a 7-week period, both female and male students, on average, reported an increased interest in their reported career choices in the computer science field. While an increase in reported career choices was evident, it is important to note that sixth grade students were exposed to and engaged in a learning experience with the Energy Station and Innovation Station. This was a 2-day field trip experience where students learned about careers in the STEM and the energy field, which may or may not have had an effect on their reported career choice. Female data showed increased interest in the computer science field. Students were provided with a pre- and postsurvey to gain insight on reported career interests and one open-ended question to list their career choice. Again, this survey was only provided to students in third through sixth grade, so career choices of students in kindergarten through second grade were not reported, thus limiting the responses to a select group of students. Additionally, teachers confirmed that interest levels were high with a significant amount of their students. It is accurate to say that during this evaluation period, student interests in computer science increased from the pre- to postsurvey.

When a welcoming learning environment is created for female students, female students participate in the lessons and have a high interest in learning computer science, as seen in this evaluation. As Smith and Hung (2008) suggested, an environment that allows for stereotypes to occur creates a lack of confidence, low self-esteem, and limited hopes for the future in the STEM field. This aligns to the work of Ramsey and colleagues (2013), which concluded that negative STEM identity is created when females are exposed to educational settings that lack support in a gender inclusive atmosphere. The results of the student survey showed that when students were provided an opportunity to learn computer science in a gender equitable environment, students, on average, responded positively to it.

Evaluation Question 5

Do student outcomes differ based on the quality of the program's implementation?

The evaluation investigated whether student outcomes differed based on program use. It was found that students who use the program at least 2-3 times per week for a period of 30-45 minutes per session generally had higher mean outcomes. Frequent use of the program was a key element in understanding student outcomes and for determining the quality of the program for each student. Though the frequency of time using the program did not necessarily prove that the program was of quality, comparisons of outcome data did prove that the amount of program time affected student survey responses. Students reported that the more they used the program, the more they enjoyed learning to code. There were several questions within the survey that asked students about their experience with using the program. Specifically, the survey looked at student perception about their coding experience, and because of the program students will want a future career in coding. Again, it was from the student perspective, and one can infer that the amount time did impact the learning experience. Questions in the survey did not explicitly ask students their perception on the quality of the program, but questions did seek to gain an understanding of their total experience. Data were analyzed by time and frequency, then mean scores were looked at to determine if the student outcomes differed from base implementation. It was found that time and frequency did positively impact student outcomes.

Considerations would be to survey students about their program likes and dislikes to gain a better understanding of the quality of the program. Survey questions should be specific about what students are learning and if they find value in the learning. This type of information would help support future growth and program refinement.

Literature in Chapter 2 reviewed STEM program efforts for young children. Earlier research indicates that there is a need for young students to develop digital literacy through STEM and computer science. The learning is crucial for the future of our students. Nager and Atkinson (2016) reported "despite the growing use of computer and software in every facet of our economy, not until recently has computer science education begun to gain traction in American school systems" (p. 18). Their research supports the importance of teaching students computer science skills. In fact, the authors shared that students need to be provided with the necessary skills to keep up with digital society. It is believed that continuing to use this program, as intended, will close the gender gap and provide elementary school students an opportunity to apply necessary skills to keep up with the digital demands in American school systems.

Interpretation Summary

The Koi Coding program has impacted both teachers and students in a positive way. Since there was moderate fidelity to the program, considerations need to be made when understanding the results of this evaluation. Teachers did demonstrate that they are implementing teaching strategies learned from professional development sessions to create a gender-neutral learning experience for students. While it is difficult to determine if cultural stereotypes were completely eliminated, findings would suggest that the program did have an impact on teacher awareness. Over the course of the evaluation period, teachers indicated that the new learning positively affected their mindset. Students were measured before and after the 7-week implementation period. Results showed that students, overall, enjoyed learning to code, and they did not see a gender difference when learning computer science. The evaluation favorably showed that the program is making an impact on students and teachers. In the next section, limitations to the program with recommendations will be discussed.

Limitations and Recommendations

As with every evaluation, this program presented limitations. First, the evaluation was conducted in a single-school setting, which limits the extent to which its findings can be generalized. The data collected describe the extent to which the effectiveness of an elementary school coding program, if implemented with fidelity, had an impact on teacher mindset and created a gender-neutral approach to computer science. Furthermore, the evaluator served as the principal in the elementary school at the onset of the evaluation. Since the evaluator was the supervisor of the program, it was necessary to review the program evaluation through both lenses. It was important for the evaluator to take a neutral position while evaluating the program. Though it was not an easy task, it was necessary to ensure this evaluation was written with a nonbias viewpoint. The findings, therefore, may have inadvertently included a bias.

During the onset of developing the program, the administrator at the school site was faced with various challenges. Since the Koi Coding program was new during this evaluation, challenges arouse with the implementation process. Some of the challenges that the school was faced with were: (a) funding for program materials; (b) scheduling conflicts with the Discovery Labs; (c) the need for more professional development; (d) time for teacher planning; and (e) continued refinement of the program. Further support and planning in these areas would help improve the overall program experience and foster future development of the program. Limitations will be discussed in detail in the subsequent sections.

Funding and Program Materials

Creating this new program required special funding to purchase devices and materials. The coding devices were purchased to help to support the learning. When the program first started, age appropriate devices were purchased and, instructionally, were at a very basic level. Digital and coding devices that were used in this program were costly. Keeping up with the rate at which students are learning to use these devices will require the school to continue to purchase materials that are age appropriate and suitable for the level of the learner. Ensuring that equitable access to the coding devices is essential to student learning. In addition, some of the digital devices have a short shelf life, so maintaining appropriate devices in the labs will be key to the teaching and learning. It is recommended that schools designate funding to run their programs. Specifically, they may seek funding from grants, fundraising efforts, or find a sponsor to support the on-going needs.

Scheduling Conflicts With the Discovery Labs

Each grade level cluster (kindergarten-second, third-fourth, and fifth-sixth) were assigned to a designated learning space named Discovery Labs. A total of three labs were located in the school and housed the grade appropriate learning devices. Teachers in each grade level worked on a schedule to share the lab space but found that scheduling conflicts occurred. Since the program required teachers to visit the lab at least 2-3 times per week, the schedule had to be redesigned a few times throughout the evaluation period in order to accommodate all classrooms. As school enrollment increases, lab schedules will pose a barrier. Program users should take note of the amount of time in the lab versus the number of days in the lab. The school should take a look at how coding devices may be used in classrooms so that fidelity can be achieved.

Need for More Professional Development

Teachers were provided with professional development sessions to prepare them for instruction. The meeting topics were limited to understanding the purpose and goals of the program. As the teachers began to utilize their skills and knowledge to teach coding to their students, it was quickly noted that they desired more professional development, particularly with lesson design integrating coding across content areas. Next steps should include more professional development to make content connections and relate that work to real-world topics.

Time for Teacher Planning

Creating a new program takes time and strategic planning. It is imperative that teachers have ample time for planning, especially when learning new content. During the evaluation period, time was provided to teachers during the instructional day so that they may plan for instruction. Teachers used grade level collaboration time to align their coding work to units they are learning in other content areas. The planning time allows for content specialists to assist teachers in learning the content and planning for their lessons. It is suggested that planning time continue to be provided to teachers as they refine their practice with coding.

Continued Refinement of the Program

The data collected from this evaluation will assist in gauging next steps for the program. The most difficult part in starting the program was getting teachers on board and ensuring they were comfortable with teaching coding. Survey data serve as an avenue to gather input from teachers and students. The program should continue to use the practice of gathering input from participants to ensure the program is meeting the needs of both teachers and students.

Summary of Limitations

Considering limitations in this evaluation is necessary to gain a complete understanding of the program requirements. Future evaluation implications will be useful in determining next steps for the program. In the next section, future evaluation implications will be discussed.

Implications for Future Leaders

The K-6 elementary school developed a coding program to address the need for teaching student's computer science to keep up with the demands of STEM and digital learning. As research suggested in Chapter 2, cultural and gender stereotypes effect female participation in the computer science college tracks and the American workforce. The implications for school leadership would require a closer examination of the effects of teacher preparedness and whether or not the program has a long-term effect on closing the gender gap for females in computer science.

Leadership plays a very important role in the success of the program. Creating a new program has its challenges, but school leaders seeking to start a program, such as the Koi Coding program, must be willing to take risks. Some might say that core instruction time is being taken away by coding, but one would argue that learning computer science is an essential component for student learning and their future. The Koi Coding program offers teachers an opportunity to align teaching to the 21st century. Furthermore, lessons engage students to connect their content learning and apply it to solve real-world problems through coding. What a leader should not do is restrict the learning possibilities for teachers and students. Results from this evaluation helped to shape considerations for leaders who may implement such a program.

The Koi Coding program requires all students to use essential skills, such as collaboration, communication, and problem solving. These skills are California Content Standards aligned, so taking the leap to start a program like this can boost student learning in those areas. To begin, school leaders must have a vision, create buy-in, trust in the program they are creating, but most importantly must believe that gender equality can be achieved. The school leaders' influence in creating a vision that embraces innovation is critical to the development of the program. Teachers and students alike need to contribute and believe in 21st century learning. It was evident that the program embraced components of the schools' mission, which states:

> Our mission is to provide an inclusive education, which unifies and empowers diversity for all learners. While supporting 21st century learning, we embrace culture and language and celebrate individuality through collaboration, critical thinking, and innovation. With a deep desire to learn, these practices and values will develop and strengthen our community.

It is clear that the schools' mission is aligned to the program goals and can be used to remind teachers of the purpose for creating a 21st century learning experience. Leaders developing a new program must consider their vision for the new learning and how it relates to their school mission to create buy-in.

It is essential for leaders starting a program to not only have a clear vision, but to establish well-defined learning goals. It is highly suggested that opportunities for new learning are provided to teachers to equip them with necessary skills as the program evolves. Throughout this evaluation, professional development was essential for teachers as it helped to build their content knowledge. Professional development topics were derived from teacher input surveys. Surveys were given out periodically to gain insight on the topics and content teachers wanted to learn more about. This information was fundamental in ensuring that professional development sessions met the needs of the teachers. Some learning sessions were differentiated by whole group, grade level, or grade level clusters depending on the learning outcomes and participant needs. A consideration for leaders would be to ensure that teachers are challenged to perfect their craft and develop expertise with coding through on-going professional development. Gaining teacher input will support leaders in developing learning sessions that will benefit the overall learning content. Leaders should encourage their teaching team to take risks and experiment with the content to make the learning relevant for their students.

After receiving professional development, teachers were provided with planning time, as it was a vital component to teacher and grade level development. In addition to individual planning time, teachers received grade level and cross-grade level collaboration time to create lessons. At times, experts were invited into collaboration sessions to provide insight on a specific coding topic or skill. Collaboration sessions allowed for teachers to create new lessons, calibrate their teaching, and share resources. A shared notebook was created where the agenda, notes from the planning sessions, and resources were stored. The administration and teachers had access to the collaboration notebooks and resources to ensure best practices and lessons were being shared. During the planning sessions and prior to the start of using the Discovery Labs, teachers created a standard set of lab norms for students. The norms helped remind teachers and students what the expectations were for using the labs and equipment. After students became familiar with using the labs and devices, teachers employed coding lessons, which were aligned to the content standards. Considerations would be that each session or project should include outcomes that are aligned to grade level standards. Additionally, as students advance through the grade levels, they will need to be challenged with content that is appropriate to their learning needs. Teachers will need to continue to refine their practice through collaboration sessions and provide on-going input to leaders as they develop their coding skills and seek new learning through professional development.

Finally, leaders should consider ways in which they can support a gender-neutral, inclusive learning environment. Creating a learning environment that is equitable, gender-balanced, and free of stereotypes are all important components in closing the gender gap. As instructors deepen their knowledge of new content, ensuring inclusivity must be at the forefront of the planning to create a gender-neutral learning experience for students. Leaders must foster and demonstrate how to create such an environment. This may be accomplished by specifically identifying these practices and including them in the actual lesson plans. Though teachers were provided with planning and lesson development opportunities, lesson plans did not explicitly call out what practices were used to create a gender-neutral learning session. Leaders employing the Koi Coding program, should ensure that teachers identify these best practices and include them in actual lesson plans. This can be done by explicitly planning lessons with gender equality in mind. Instructional leaders help shape and develop teachers.

Information gathered from this evaluation provides insight on how a leader may implement a program, such as the Koi Coding program, at their respective sites. While this program is in its developmental stages, it may have an impact on closing the gender gap. Though the data collected from this evaluation varied and were limited to a 7-week period, the Koi Coding program does show it had a positive impact on both students and teachers. Fidelity to the program may have a long-term effect of closing the gender-gap as it continues to be developed and refined.

Future Evaluation Considerations

Further evaluation is needed to determine the long-term effects of the Koi Coding program. It will be key for the participants to continue to use the program as outlined in the program description to ensure program fidelity. As students move up the grade levels, program use and a strong commitment to using the program will be vital to the program's success. Teachers will need to ensure they are visiting the Discovery Labs as intended. In addition, a vertical-collaboration among the grade levels will allow for a discussion for refinement of the program. Using the program as intended will help build students' knowledge and skills from a very basic level to a more complex level of understanding, as students engage in coding year after year.

As the program continues to develop and evolve, teachers should be provided with surveys to track their perceived success with professional development strategies and with the program as a whole. Focus group participation will be vital in receiving additional information about the program and to gain insight on guiding next steps for the program. Students should be provided with on-going surveys to provide school leaders with key information about the program and to see if the program is making an impact overall on student learning.

Furthermore, future considerations should include implementing the program across all grade levels to maintain a high student interest level. Students are highly motivated to participate in coding lessons, so guaranteeing that teachers encourage the learning in a gender bias environment will be key. To take it a step further, it is suggested that additional professional development be provided to teachers so that they may connect the computer science knowledge into other content areas. A connection to the Engineer and Design Process (EDP) should be explored, so students can innovate, create, and design to solve real world problems.

A computer science learning environment that is gender equitable is suggested for all students. It was found that using the program had an effect on students' perception and overall experience of the program; therefore, ensuring that students use the program for at least 2-3 times per week for at least 30-45 minutes per session is highly suggested. Also, teachers should be fully committed to using the program provided they have had sufficient training. A next step would be to further examine the quality of the programs' delivery from a student lens.

Maintenance of the current program will offer students a learning experience that is free from stereotypes. The school or participants of the program should track the reported career choices to see if multiple years of using the program has a long-term impact on students. The program should add a component that would expose students to various careers in computer science. To have a lasting impact on closing the gender-gap, on-going use of this program is vital. One schools' efforts to create a gender-neutral, inclusive learning environment is one step closer to making a difference for all students.

Conclusion

While this program is in its beginning stages of development, future research is recommended to evaluate the long-term effects the program has on female students and their reported education and career paths. This evaluation was conducted to evaluate the short-term effects of the program and teacher preparedness. The results of this evaluation suggested that the Koi Coding program offered teachers and students an opportunity to close the gender gap in computer science. Though the program was evaluated at one school, the efforts of implementing computer science to elementary school age children proved to be a positive step forward to closing the gender gap and eliminating gender stereotypes. In addition, the evaluation confirmed that by preparing teachers to teach computer science, and by providing them with skills to create gender-neutral learning environments, students and teachers had a positive experience with the coding program.

More research must be conducted to see the long-term effects of this program. The evaluator agrees that this program has made an impact on the school, students, and teachers and should be replicated at other school sites. This program has provided female students a standing chance in continuing on the STEM and computer science pathway to, hopefully, eliminate the gender gap that exists in the American workforce.

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APPENDIX A

Student Survey (Pre) Questions

Learning to Code Will Be Easy

Thank you for participating in the Muraoka Koi Coding program experience. The purpose of this survey is to gain insight about your coding experience in the Discovery Labs. Your feedback is vital in improving and maintaining the quality of the program we now have.

Section I—Student Information

The information provided in this first section is to learn about you and how often you visit the Discovery Lab.

1. Please enter your first and last name
   [First Name]
   [Last Name]

2. Please select your teacher's name (drop down menu of teacher names)

3. What grade are you in?
   a. Kindergarten
   b. 1st
   c. 2nd
   d. 3rd
   e. 4th
   f. 5th
   g. 6th

4. What is your gender?
   a. Boy
   b. Girl
   c. Decline to state

5. I use the Discovery Lab (Koi Coding Program)
   a. 0 Days a week
   b. 1 Day a week
   c. 2 Days a week
   d. 3 Days a week
   e. 4 or more days a week

6. I used the Discovery Labs last school year (2017-18)
    a. Not at all
    b. 1 Day per week
    c. 2 Days a week
    d. 3 Days a week
    e. 4 or more days a week

Strongly Agree, Agree, Disagree, Strongly Disagree

7. I like coming to school to learn new things

Section II—Present Coding

The questions below will help us better understand your experience as a learner.

Strongly Agree, Agree, Disagree, Strongly Disagree

8. I enjoy learning in the Discovery Lab
9. Boys and girls in my class like to code
10. Learning about coding is important to me
11. The Discovery Lab helps me to learn to code
12. School is fun because I will be learning to code in the Discovery Labs
13. I am excited to learn about coding
14. Learning to code will be easy
15. My teacher will be helping me learn to code in the Discover Lab
16. Coding will help me learn in other subjects (math, science, language arts, etc.)
17. I will be a better coder because I will be using the Discovery Lab 3 times per week

Section II—Future Coding

The questions below will help us better understand you as a future coder.

Strongly Agree, Agree, Disagree, Strongly Disagree

18. I hope that my future career allow me to use my coding skills
19. I will be good at coding someday
20. Learning to code is important for my future
21. In the future, I want to be a [Insert Career]

Thank you for your participation.

APPENDIX B

Student Survey (Post) Questions

Learning to Code Will Be Easy

Thank you for participating in the Muraoka Koi Coding program experience. The purpose of this survey is to gain insight about your coding experience in the Discovery Labs. Your feedback is vital in improving and maintaining the quality of the program we now have.

Section I—Student Information

The information provided in this first section is to learn about you and how often you visit the Discovery Lab.

1. Please enter your first and last name
   [First Name]
   [Last Name]

2. Please select your teacher's name (drop down menu of teacher names)

3. What grade are you in?
   a. Kindergarten
   b. 1st
   c. 2nd
   d. 3rd
   e. 4th
   f. 5th
   g. 6th

4. What is your gender?
   a. Boy
   b. Girl
   c. Decline to state

5. I used the Discovery Lab (Koi Coding Program)
   a. 0 Days a week
   b. 1 Day a week
   c. 2 Days a week
   d. 3 Days a week
   e. 4 or more days a week

6. I used the Discovery Labs last school year (2017-18)
    a. Not at all
    b. 1-2 Days a week
    c. 2-3 Days a week
    d. 4 or more days a week

Strongly Agree, Agree, Disagree, Strongly Disagree

7. I like coming to school to learn new things

Section II—Present Coding

The questions below will help us better understand your experience as a learner.

Strongly Agree, Agree, Disagree, Strongly Disagree

8. I enjoyed learning in the Discovery Lab
9. Boys and girls in my class like to code
10. Learning computer science and coding is important to me
11. My work in the Discovery Lab helps me to learn to code
12. School is fun because I learned to code in the Discovery Lab
13. I am excited because I have learned about computer science and coding
14. Learning to code is easy
15. My teacher helped me learn to code in the Discover Lab
16. What I've learned about coding helps me learn in other subjects (math, science, language arts, etc.)
17. I will be a better coder because I used the Discovery Lab 3 times per week

Section II—Future Coding

The questions below will help us better understand you as a future coder.

Strongly Agree, Agree, Disagree, Strongly Disagree

18. I hope that my future career will be in computer science so I can use my coding skills
19. I will be good at coding and computer science
20. I would like to be a coder or be in the computer science field someday
21. Learning to code is important for my future
22. When I grow up, I want to be a [insert career]

Thank you for your participation.

APPENDIX C

Teacher Survey (Pre and Post)

Thank you for participating in the Muraoka Koi Coding program experience. As you know, Muraoka was built with three Discovery Labs for grade level clusters K-2, 3-4, and 5-6. The labs are designed to provide students an opportunity to learn to code while on-going professional development has been provided to teachers to support them with teaching coding. Each lab is supplied with age appropriate coding devices that are accessible for students and teachers.

This survey is designed to provide data that will help us evaluate and improve the Koi Coding program. It is not designed to evaluate teachers whatsoever. The responses you provide will help to guide next steps for professional development and teacher support. Your perspective and the information you provide at the beginning and end of a 7-week learning cycle will be collected and analyzed for the sole purpose of understanding the implementation of the program. Again, this will not evaluate you, the teacher, in any way.

Section I: About You

The information provided in this first section is to understand a bit about you, your experience, and how often you visit the Discovery Lab for your grade level cluster.

1. Please enter your name. This will be kept confidential and will be used only to match your responses at the beginning and end of the program. Only the evaluator will see this information.

   [First Name]

   [Last Name]

2. What grade do you teach?
   a. Kindergarten
   b. 1st
   c. 2nd
   d. 3rd
   e. 4th
   f. 5th
   g. 6th
   h. SDC

3. How long have you been teaching?
   a. 0-1
   b. 2
   c. 3
   d. 4
   e. 5
   f. 6
   g. 7
   h. 8
   i. 9
   j. 10 or more years

4. I use the Discovery Lab (Koi Coding Program)
   a. 0 Days a week
   b. 1 Day a week
   c. 2 Days a week
   d. 3 Days a week
   e. 4 or more days a week

5. I used the Discovery Labs last school year (2017-18)
   a. Not at all
   b. 1 Day a week
   c. 2 Days a week
   d. 3 Days a week
   e. 4 or more days a week

6. I teach coding
   a. 0 Days a week
   b. 1 Day a week
   c. 2 Days a week
   d. 3 Days a week
   e. 4 or more days a week

7. The duration of my coding lessons/sessions are approximately
   a. Less than 25 minutes
   b. 25-34 minutes
   c. 35-44 minutes
   d. 45-55 minutes
   e. More than 55 minutes

Please indicate your frequency with the items below:

Never, Sometimes, Often, Always

8. I develop coding lessons with my grade level team to ensure consistency across the grade level
9. I utilize the Digital Media Arts teacher when planning coding lessons
10. I co-teach with the Digital Media Arts teacher
11. I plan co-teaching lessons with the Digital Media Arts teacher to learn how to teach

Section II: Professional Development

In Section II, we are interested in your perspective on the professional development you have received aligned to coding. The questions below will help us better understand your experience as a learner.

Strongly Agree, Agree, Disagree, Strongly Disagree

12. Through professional development, I am developing skills and knowledge to teach coding
13. Through professional development, I am developing skills and knowledge to teach the engineer and design process
14. The coding with the engineer and design process professional development is valuable for my teaching
15. The professional development sessions in which I have participated have prepared me to facilitate the teaching of coding with the engineer and design process in the discovery labs
16. The professional development I received has helped me reflect on the ways my school can increase the use of coding in the discovery labs
17. The professional development that I have received has helped me feel more confident in teaching coding to my students
18. I want more professional development so I can learn more about coding with the engineer and design process

Based on each item, please indicate you familiarity with each concept.

I am not familiar, I have limited knowledge, I can explain it to someone, I can explain and begin to use/apply to students in the classroom

19. The purpose of a Makerspace
20. Discovery Lab Coding (Beebots, Makey-Makey, Dash & Dots, Ardinos, code.org, Scratch)
21. Engineer and Design Process
22. Science/Design Notebooks

Section III: Perception and Mindset on Developing Coding Skills

In Section III, we seek to understand your perception and your confidence before you began to teach coding.

Not at all, To some extent, To a moderate extent, To a large extent

23. My level of confidence to teach coding affects my mindset
24. My confidence level in teaching coding has increased because of the professional development I have received
25. Developing skills to teach coding has affected my mindset in a positive way
26. I enjoy learning how code
27. I enjoy teaching students to code
28. I have a growth mindset about teaching coding to my students

Section IV: Gender Neutral Approach to Teaching Coding

In Section IV, we seek to gain your insight on how the professional development that you have received has prepared you to provide a gender-neutral learning experience for your students.

Strongly Agree, Agree, Disagree, Strongly Disagree

29. All students in my classroom have equal access to coding lessons
30. I find that the gender of students determines the interest in the coding lessons
31. I find that boys do better with the coding lessons than girls
32. I find that girls do better with coding lessons than boys
33. When I teach coding to my students, I use strategies I have learned to engage both boys and girls in the learning process
34. When I plan my lessons, I ensure that I strategically partner students to create a gender balance learning experience

Section V: Your Perceived Success

In Section V, please indicate your success with teaching coding.

Strongly Agree, Agree, Disagree, Strongly Disagree

35. The coding program I implement improves student learning
36. I have seen an increase in students making connections to what they are learning and then applying it to the coding lessons that I teach
37. When I connect coding lessons to core learning, students are able to better retain the information they are learning
38. I am able to effectively teach coding

Thank you for providing answers to all your questions.

APPENDIX D

Focus Group Questions and Protocol

This document provides protocol and questions for the Koi Coding program that you implemented for one focus group one session.

Focus Group Goal: The focus group will provide an opportunity for teachers to describe their perception and their overall experience with using the program.

Group Participants: The group will consist of seven teachers kindergarten through sixth grade. Teachers selected to participate meet the inclusion criteria. The focus group will last approximately 45-60 minutes in length and will be recorded.

Thank you for taking part in this focus group. Today's session is designed for teachers to share experiences with using the Koi Coding program. This session will be recorded, and any comments made are confidential. Please feel free to answer or not answer the questions that will be used in this focus group. I ask that you please speak one at a time. We have approximately 55 minutes for this session for you to openly communicate and share your thoughts.

Participant Introductions (3 Minutes)

1. Please take a moment to go around the table and state your:
   a. First and Last Name
   b. The grade level you teach

You and the Program (10 Minutes)

In this section, I would like for you to describe your experience with using the program.

1. What successes and/or challenges did you encounter with using the Koi Coding program?

Students and the Program (10 Minutes)

In this section, I would like for you to think about the experience your students had with using the Koi Coding program.

2. What were your overall observations of students and their interest level in computer science and coding?

Professional Development (20 Minutes)

In this section, I would like for you to reflect on the professional development you have received.

3. What was your mindset before you started teaching the Koi Coding program?

4. Did professional development have an impact on your mindset to teach coding? If so, in what way?

5. What specific teaching strategies have you learned in your professional development sessions that help you created a gender-neutral approach to teaching computer science coding?

6. Based on your experience with using the Koi Coding program, what additional professional development would you like to have to continue your development with computer science coding?

Reflection (10 Minutes)

This last questions is an opportunity for you to discuss your beliefs about teaching computer science coding.

7. Overall, what are your beliefs about teaching computer science coding to elementary school students?