HOW FEMALE STUDENTS’ STEM EXPERIENCES AFFECT THEIR INTEREST IN STEM
SUBJECTS AND CAREERS

By

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A dissertation submitted in partial fulfillment of
the requirements for the degree of

DOCTOR OF EDUCATION

WASHINGTON STATE UNIVERSITY
Department of Education Leadership, Sport Studies, & Educational/Counseling Psychology

MAY 2019

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the dissertation of MATTHEW JAMES HENSHAW find it satisfactory and recommend that it be accepted.

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ACKNOWLEDGMENT

I would like to acknowledge my wife, Jennifer, for her absolute support throughout this journey. I would not, and could not, have pursued and completed this degree without her by my side. I would also like to thank my parents for their tremendous encouragement and belief that I, along with my siblings, can do all things through Christ. Finally, I would like to thank all of my teachers and professors over the years, who instilled in me the belief that learning is a life-long quest.
HOW FEMALE STUDENTS’ STEM EXPERIENCES AFFECT THEIR INTEREST IN STEM SUBJECTS AND CAREERS

Abstract

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May 2019

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The purpose of the study was to contribute to the literature regarding how STEM experiences affect preadolescent female students. More specifically, the purpose was to better understand the experience of 250 female fourth, fifth, and sixth grade students at a summer STEM camp and how those experiences might impact their interest in STEM subjects and careers. The study asked, how did 4th and 5th grade female elementary students experience a summer one- to four-week STEM camp? How did their self-perception change in relation to STEM subjects and careers as they attend a summer STEM camp and shortly following? And, what were the views and perceptions about STEM subjects, careers, and instruction held by female instructors?

This study used a qualitative design employing an interpretive perspective with the view that knowledge is socially constructed from our unique vantage points based on our prior histories, interactions, and experiences. Multiple instruments were used including interviews, observation, and surveys. Six female primary student-participants were interviewed twice and observed once. Four female camp instructors served as secondary participants and were interviewed once. In addition all student camp participants were surveyed three times. Data from
these instruments were explored and analyzed through a Social Cognitive Career Theory and Culturally Relevant Teaching conceptual framework. A convergent-parallel mixed method was used in order to provide a comprehensive analysis of the research problems. Results indicated female participants had an interest in STEM subjects and careers, although less so than their male counterparts. Female participants attending camp for the first time showed the most significant growth when compared to both new and returning males and returning female participants and results maintained 6-8 weeks after the conclusion of the camp experience.
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Dedication

To the young female students in our K-12 system who are our future STEM leaders, inventors, and entrepreneurs. And to my daughters Ellie Anne and Ava Lynn whose persistent curiosity and natural inclination to understand inspire me every day and give me hope for the future.
CHAPTER ONE: INTRODUCTION

The recent advancement and pervasiveness of the field of technology has resulted in a heightened awareness and focus on the education of young people in the areas of Science, Technology, Engineering, and Mathematics (STEM). This is true at the federal, state, and more recently, district level (National Research Council [NRC], 2012, 2013). However, studies have often focused at the college or secondary 7-12 level despite the fact that we know students start making decisions about career choices related to their identity much earlier in adolescence (Linver, Davis-Kean, & Eccles, 2002; Weisgram, Bigler & Liben, 2010). In fact, studies demonstrate that students start making decision about their abilities and career choices as early as elementary (Osborne, Simon, & Tytler, 2009) and middle school (Richards, Hallock, & Schnittka, 2007).

There currently exists a gap between the number of K-12 students prepared to pursue STEM degrees and the needs of industry (Bureau of Labor Statistics, 2014; College Board, 2013). The President’s Council of Advisors on Science and Technology (NRC, 2011) estimates that universities will graduate approximately one million too few STEM graduates in the next decade. Family Socio-Economic Status (SES) also has been found to strongly correlate with STEM interest and participation starting early in life (Xie, Fang, & Shauman, 2015). Students from families with higher incomes disproportionately obtain STEM degrees and careers (Chen, 2009). Exacerbating the issue is a decline in women enrolled in many STEM degree programs (Hill, Corbett, & Rose, 2010). In fact, there has been a precipitous decline in women pursuing C.S. degrees when compared with increases in the percentage of women enrolled in other prestigious degree programs such as medical and law school (see Appendix A for complete data). National, state, and district data demonstrate that too few students are prepared for and interested
in pursuing STEM courses, degrees, and careers. This is especially true for women (Honey, Pearson, & Schweingruber, 2014; National Center for Women and Information Technology [NCWIT], 2015, 2016; NRC, 2013).

In a report from the Nation Student Clearinghouse Research Center ([NSCRC], 2015) researchers highlighted discrepancies in degree attainment between men and women. The table below demonstrates the scope of the problem facing the United States today. The table contains data comparing the gender distribution of bachelor’s degrees in science and engineering disciplines in the years 2004 and 2014 by percent.

Table 1

*Comparison of Bachelor’s Degree Completion in Science and Engineering Disciplines by Gender – 2004 to 2014*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Engineering</th>
<th>Computer Science</th>
<th>Earth Science</th>
<th>Physical Science</th>
<th>Mathematics</th>
<th>Biological Science</th>
<th>Social and Psychology</th>
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</thead>
<tbody>
<tr>
<td>Women</td>
<td>-1%</td>
<td>-5%</td>
<td>-2%</td>
<td>-3%</td>
<td>-3%</td>
<td>-2%</td>
<td>-1%</td>
</tr>
<tr>
<td>Men</td>
<td>1%</td>
<td>5%</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Difference</td>
<td>2%</td>
<td>10%</td>
<td>4%</td>
<td>6%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: (NSCRC, 2015)

These data demonstrate that there is a significant gap in degree attainment in what are often called the hard sciences between women and men. In all degrees the trend is negative for women. This trend was even more pronounced for master’s and doctoral degrees (NSCRC, 2015). Furthermore, women were least represented in engineering and computer science which account for more than 80% of the STEM workforce and pay more than other STEM professions (Corbett, & Hill, 2015). This is both an equity and economic issue. The total number of both men and women pursing science and engineering degrees as a percentage of all degrees has
essentially remained flat while the demand from the private sector continues to rise (Bureau of Labor Statistics, 2014; NSCRC, 2015). Another challenge is women leaving these fields.

In addition to less women pursuing STEM degrees women are being “pushed out” of STEM careers in record numbers, exacerbating the disparity (Corbett, & Hill, 2015). The term “push out” has been used to describe the cultural conditions in higher education and the work force that are biased against women and towards men. This is despite the fact that substantial increases by women in educational achievements in science and math have been realized in recent decades (National Science and Technology Council, 2013; NRC, 2011). In a recent nationally representative survey by the Pew Research Center (2018) a majority of women in STEM roles were found to experience workplace discrimination and at higher rates than other professions (Funk & Parker, 2018). Corbett and Hill (2015) found similar results in their report including workplace gender and evaluation bias which they found began in undergraduate school. These findings have been replicated in other studies in both college and workplace environments (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012; Reuben, Sapienza, & Zingales, 2014) and is worse when compared to other nations (Williams, Phillips, & Hall, 2014). The phenomena of women being pushed out of STEM careers further exacerbates the STEM workforce imbalance.

Diversity of representation matters in STEM professions. Women and other underrepresented groups possess varying perspectives and experiences which they bring to bear on solving problems and developing new innovations (Corbett, & Hill, 2015; NSCRC, 2015). America cannot simply afford to ignore the insights and perspectives of over half of the population when solving the engineering and technological problems of tomorrow. Researchers such as Wajcman (2004) and others in the field of technoscience have written extensively about
the perils of such a path. Examples include reproductive technologies which until recently have not enjoyed equal funding and support (Wajcman, 2004).

While core math, technology and science competencies and skills are associated with STEM course taking patterns, degree selection, and career attainment (Honey et al., 2014; Congressional Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development [CAWMSET], 2000; Miller, 2015) they are not sufficient (Ball, Huang, Cotten, & Rikard, 2017; Hackett & Betz, 1981; Hughes, 2001). Educators, parents, and community members must also understand how students’ self-efficacy and identity factor into later STEM interest and participation (Andersen, 2013; Bandura, 1963, 1977, 1986; Erikson, 1968; Hughes, 2001).

Studies have shown that in general, female students have lower self-efficacy in math and science than do their peers (Shapiro & Williams, 2012; Zeldin, Britner, & Pajares, 2008). This is true for STEM in K-12 and later in college (Corbett, & Hill, 2015; Shapiro & Williams, 2012; Zeldin et al., 2008). From an early age, studies show differences in how students identify with math and science. Boys tend to have more confidence in their abilities and both boys and girls can identify more male role models in STEM fields starting in elementary school (National Academy of Engineering [NAE], 2008). While girls perform as well or better than boys in math and science in high school, women are less likely to see a correlation between their interests and career goals and the STEM profession (Blickenstaff, 2005; Williams, 2014; Xie et al., 2015). To ensure we meet the demands of tomorrow and ensure we have equity of representation in the STEM workforce, additional research focusing on identifying strategies, practices, and programs that improve adolescent girls’ self-confidence and interest in STEM are needed.
Research Problem

The realization of social justice in our educational system and larger society is vital in a representative democracy. President Lincoln said it best when he extoled in his Gettysburg Address that “government is of the people, by the people, and for the people” (Lincoln, 1863, p. 1). A more recent president, Barack Obama, affirmed these sentiments when discussing the current lack of women in the U.S. STEM workforce (Corbett & Hill, 2014). If this is true, government and all its entities, including educational institutions, should serve all people in ways that equally benefit our diverse population. If we have equity of opportunity but not equity of outcomes, and those outcomes are tied to anything other than merit then our government is not truly representative of all people. If it is representative there would be, “full and equal participation of all groups in a society that is mutually shaped to meet their needs” (Bell, 2007, p. 1). Government and schools, therefore, should be structured and continually adapt to meet the ever-changing needs of all students, not just those of the dominant culture (Camicia, 2015). In a democratic society, if one segment of the population’s lived experience is unjust then all of society suffers (Bell, 2007).

The United States does not adequately prepare enough students for the twenty-first century. Many students do not have the opportunity to pursue STEM degrees because they are not adequately prepared. Many others, particularly female students and students of color are either choosing to not pursue STEM careers or are not prepared to do so (Bureau of Labor Statistics, 2014; College Board, 2013; NCWIT, 2016). In fact, between 2000 and 2014 seven percent fewer first-year university women indicated they are interested in pursuing a STEM degree (NCWIT, 2015). Some would say we’re going backwards. Districts should strive to help young women make connections between their passions and talents and STEM careers. Districts
need to develop compelling STEM programs as part of their extra-curricular and core science or math instructional programming. In addition, school districts must help teachers and parents better support and inform female students about these opportunities from a young age. Districts must better understand how to provide experiences and opportunities for young women which expose them to STEM and help them increase their interest and awareness in STEM course and career opportunities. This study is designed to help illuminate this dynamic. How do fourth and fifth grade female elementary students experience a one- to four-week summer STEM camp? How does their self-perception change in relation to STEM subjects and careers as they attend the STEM camp?

**Purpose of the Study**

By the time students reach high school many have already decided that STEM courses and careers are out of reach (College Board, 2013; NCWIT, 2016). Most research attempting to answer the programmatic impacts of STEM initiatives focuses at middle or high school level (NSTC, 2011; 2013; NRC, 2013). We know that students start making decisions related to their future and how they see themselves in relation to STEM domains and various career clusters much earlier (Linver, Davis-Kean, & Eccles, 2002; Weisgram, Bigler & Liben, 2010). More research studying the impacts of STEM efforts during and after the traditional school day at the elementary level is needed.

The overall purpose of the study is to contribute to the literature regarding how STEM experiences affect preadolescent female students. More specifically, the purpose is to better understand the experience of female fourth and fifth grade students at a summer STEM camp and how those experiences might impact their interest in STEM subjects and careers. Few studies focus on the intersection of gender, STEM, and preadolescent youth. Furthermore, few if
any focus on the persistence of new or changed STEM attitudes and beliefs following STEM experiences. The design of this study allowed for data collection at several points over time including six to eight weeks after the STEM experience concludes. This research strove to provide additional insights into how STEM experiences such as STEM camps might be leveraged to increase female participation in STEM courses and careers through changes to attitude and self-perception.

**Professional Significance**

At this time, most empirical research regarding STEM and females has focused on college and careers (Flemming, 2011; NRC, 2012; NSTC, 2013; Varney et al., 2012; Williams, 2014). Additionally, some research has been conducted at the high-school level but far less at the elementary level (CEOSE, 2017). Related research on science and career choices shows that students start making decisions about which careers and majors align with their interest and identities as early as third and fourth grade (Eccles & Wang, 2016; Hackett & Betz, 1981; Lent et al, 2005). The few empirical studies that looked at STEM and STEM camps at elementary did not focus on gender, career aspirations, or whether changes in perception persisted over time.

STEM career opportunities are growing and are projected to continue to grow into the future, particularly in our state of Washington (Carnevale, Melton, & Smith, 2011). International peer countries continue to outperform the U.S. in math and science. In addition, the United States as a whole does not graduate enough STEM-ready students to meet current demand. This is also true in the district under study, Spokane Public Schools. We are failing to graduate enough students who are STEM-ready and in many of our STEM camps and classes females are grossly underrepresented (J. Hutchens, personal communication, September 12, 2018). To meet the growing STEM workforce demand, the U.S. needs more students to be interested and prepared to
study and work in STEM career fields. Educators have an ethical obligation to current and future generations to ensure our STEM workforce is equitable and that all female students and college graduates who choose to do so have an opportunity to pursue STEM careers.

**Research Questions**

The research questions below were designed to help thoroughly explore the experiences of, and gain insight into, preadolescent beliefs and attitudes regarding STEM subjects and careers. The following research questions provided a frame for this study:

1. What are the views and perceptions about STEM subjects and careers held by female preadolescent students at the fourth, fifth, and sixth grade levels at a STEM camp?
2. What are the perceptions about STEM subjects, careers, and instruction held by female instructors of the fourth, fifth, and sixth grade level participants at a summer STEM camp?
3. How did preadolescent students’ attitudes and perceptions change regarding career aspirations and interest in STEM subjects, courses, and clubs?

**Conceptual Framework**

Miles and Huberman (1994) defined a conceptual framework as a set of assumptions, concepts, beliefs, theories, and expectations that have a relationship between each part of a system that is used to explain and support a researcher. In this section I provide a brief introduction to Culturally Relevant Pedagogy and Social Cognitive Career Theory to show how these concepts interconnect to form the conceptual framework used within this study. A discussion of the history of STEM policy and STEM strategies along with how they intersect with CRP and SCCT can be found within the literature review in Chapter 2.
When educators ensure they consider their students’ diversity of experience this is what Gloria Ladson-Billings (1992) coined *culturally relevant teaching* (CRT). Geneva Gay (2010) explains it this way saying that CRT “uses the cultural knowledge, prior experiences, frames of reference, and performance types of ethnically diverse students to make learning more relevant and effective” (2010, p. 3). I will share literature below that demonstrates how STEM education and STEM careers have been found to be gender-biased toward males in U.S. culture, and therefore not culturally relevant and responsive for female students (Blickenstaff, 2005; Chen & Soldner, 2013; Moss-Racusin, Brescoll, & Handelsman, 2012).

Social Cognitive Career Theory (SCCT) introduced by Lent, Brown, and Hackett (Lent, Brown, & Hackett, 1994; Lent et al., 2005) is a “useful theoretical lens to understand the mitigating factors that lead to STEM career intent and the unique situation that underrepresented groups are in with respect to their career choice” (Wagstaff, 2014, p. 46). The SCCT framework builds upon Bandura’s (1971, 1986) Social Cognitive Theory (SCT) discussed further in chapter two and has three interrelated models including (a) career interest and awareness, (b) academic and career choice making, and (c) performance and persistence (Lent et al., 1994). The framework helps explain how these three constructs relate to both personal and contextual factors which disproportionally impact underrepresented groups, including females in STEM education and careers.

For all students to benefit and see relevance, STEM courses and other educational opportunities must first be culturally relevant for all learners in our society. This is a foundational component for successful STEM education. Therefore, CRT practices must be embedded throughout the three models of SCCT introduced above and discussed in further detail in chapter
two. For this reason, CRT will be embedded within the discussion of findings in chapter five for each of the three SCCT models, rather than discussed separately.

**Definition of Terms**

*Constructivism:* Constructivism as a paradigm or worldview posits that learning is an active, constructive process. The learner is an information constructor. People actively construct or create their own subjective representations of objective reality. New information is linked to prior knowledge.

*Culturally relevant teaching:* Using the cultural knowledge, prior experiences, frames of reference, and performance types of ethnically diverse students to make learning more relevant and effective (Gay, 2010).

*Extracurricular learning experiences.* Structured activities that occur outside of the official school day.

*Gender inequality.* Differences or disparities in individuals due to gender (Archer et al., 2010).

*Gender gap.* The discrepancy in opportunities, status, attitudes, between males and females.

*Place-Based Education.* Place-based education (PBE) immerses students in local heritage, cultures, landscapes, opportunities and experiences, using these as a foundation for the study of language arts, mathematics, social studies, science and other subjects across the curriculum (Center for Place-based Learning and Community Engagement, 2018).

*Preadolescent.* Age range of 10 to 12 years old.

*Self-Efficacy.* One’s belief about their ability to accomplish specific tasks (Bandura, 1986).

*STEM.* The academic and professional disciplines of science, technology, engineering and mathematics.
Organization of the Dissertation

Chapter one provides an introduction and overview of the research topic that frames the research questions. The review of the literature in chapter two is presented in five sections: (a) brief review of U.S. education STEM policy, (b) an overview of culturally relevant pedagogy, (c) social cognitive theory and social cognitive career theory, and (d) a review of school-based STEM strategies. I will end the chapter with a conclusion section. Chapter three details the methods of the study including limitations, ethics, and researcher positionality. In chapter four, the research findings and emergent themes are outlined. In chapter five of this report, I provide a discussion of research question findings and discuss the findings through the lens of the study’s conceptual framework. Finally, implications and opportunities for further research are reviewed.
CHAPTER TWO: LITERATURE REVIEW

A Brief Review of U.S. Education STEM Policy

In response to the ever-growing technological landscape in the United States, governmental organizations have given more of their attention to STEM education and policy. This is true at the federal, state, and more recently, district level (Committee on the Evaluation Framework for Successful K-12 STEM Education et al., 2012; National Research Council (U.S.). Committee on the Evaluation Framework for Successful K-12 STEM Education, 2013). However, current calls for STEM integration, a focus on inquiry-based instruction, and additional time for learning these subjects are not new (Honey, Pearson, & Schweingruber, 2014; Kelley & Knowles, 2016; Kelley, 2012; Miller, 2015). Pannabecker (2004) makes this point clearly when he states, “current efforts in technology education to integrate math, science, and technology also have an extensive heritage, although much of that heritage has either been neglected or ignored” (p. 78). This should not be a surprise given the field of education is largely ahistorical, recycling past strategies and calling them by another name (Kliebard, 1970; Ravitch, 2000).

Educational leaders must resist quick fixes or pressures from special interest groups. Instead, they must rely on the extant educational research base of best practices when designing STEM initiatives, interventions, and curricula (Honey et al., 2014; Miller, 2015; NRC, 2011; Williams, 2014) while the research community continues to learn and better understand which STEM specific strategies are most fruitful (NRC, 2012; Williams, 2014). Leaders must also monitor the impacts of their policies to measure their effectiveness and ensure they are equitable.

Research shows that girls who participate in elementary school STEM programs benefit from increased confidence (Craig, 2014; Dell, Christman, & Garrick, 2011), participate more in
later STEM opportunities (NRC, 2011; Richards, Hallock, & Schnittka, 2007), and have increased positive feelings about STEM careers (Flemming, 2011; Varney et al., 2012; Williams, 2014). As has been discussed above, there is a need for more STEM workers (Bureau of Labor Statistics, 2014; College Board, 2013) and far too few females are majoring and working in many STEM fields (Hill, Corbett, & Rose, 2010). Worse still, Black, Latina, and Asian women are grossly underrepresented (NRC, 2014). For example, in 2015, just twenty-five percent of the computing workforce were women, and less than 10% were women of color: 5% were Asian, 3% were Black, and 1% were Latino. (NCWIT, 2016) Except for Asian women, these percentages are vastly underrepresented when compared to their percentage of the larger population: 2.7% Asian, 6.3% Black, 8.75% Latino (NCWIT, 2016). How then can we increase the percentage of female students in K-12 education interested in and prepared for pursing STEM careers? Below I will outline current federal and state policy efforts which aim to reduce gaps and improve equity in STEM.

**Federal STEM Policy and Equity**

The United States has arguably been economically dominant for the last half-century (Miller, 2005). During this time several high-profile reports and commissions, such as *A Nation at Risk*, have been issued warning Americans of the need to increase the rigor of K-12 education, particularly in the areas of mathematics and science. These reports and commissions have served as catalysts for educational change and legislative action (Woodruff, 2013). Following the successful Russian launch of the *Sputnik* satellite the U.S. Congress passed the National Defense Education Act and increased the National Science Foundation’s appropriation ten-fold in less than ten years which helped, among other things, students pursue science and math degrees who otherwise could not afford to do so (Maher, 2016).
For the first time scientists, rather than educators, were influencing science curricula and pedagogy (Maher, 2016). During the early 1980s an influential report entitled “Project Synthesis” called for a more constructivist approach to teaching science, including lab science, which continues today (Yager, 2015). The aims of the report were later embedded into the 1996 National Science Education Standards which included the STEM acronym for the first time (Yager, 2015). In 1993 by Executive Order, the National Science and Technology Council (NSTC) was established. “This Cabinet-level council is the principal body within the executive branch that coordinates science and technology policy across the diverse entities that make up the Federal research and development enterprise” (NSTC, 2012, p. xi).

More recently, the Next Generation Science Standards (NGSS) were formed after a call for more integration across subjects from the National Science Foundation and the National Research Council; the Carnegie Corporation, NSTA, and others collaborated to develop them (Pruitt, 2014). These standards emphasized engineering K-12 for the first time. Similar to the Common Core State Standards, NGSS are fewer in number with the hope of developing greater understanding and depth of knowledge as well as encouraging student interest and pursuit of science beyond K-12 (Pruitt, 2014).

During the early 2000s the Bush administration and Congress continued to emphasize and prioritize STEM. The President developed the STEM Education Coalition, made up of business and industry leaders (Angle et al., 2016) and the President’s Council of Advisors on Science and Technology (NRC, 2011) to inform policy and garner support from the private sector for STEM initiatives. In 2010, a new STEM agency was developed within the Department of Education when Congress passed the America COMPETES Act (National Center for Education Statistics, 2015). This same legislation formed the Committee on Science,
Technology, Engineering, and Mathematics Education (CoSTEM) within NSCT (NSTC, 2012). CoSTEM developed and released the Federal STEM Strategic Plan in 2013 (NSTC, 2013). This plan prioritizes funding to support STEM education and workforce development and supports agency coordination efforts. A significant goal included in the plan calls for efforts to increase representation in STEM degrees and the workforce for underrepresented groups including minorities and women (NSTC, 2013). In addition, STEM continued to be strongly referenced within the 2010 Reauthorization of the Elementary and Secondary Education Act. In the same year, despite the Great Recession, the United States devoted 3.4 billion dollars to STEM (Douglas & Strobel, 2015).

However, two-thirds of the 3.4 billion dollars was spent by either the Department of Education or the National Science Foundation (NSTC, 2012). Nearly a third, or 28%, was spent to support workforce needs of government agencies (NSTC, 2011). The same report found that the U.S. government “spends $1.1 billion on investments that have the primary goals of targeting groups that are underrepresented in STEM, while nearly every other STEM education investment has this as a secondary goal” (NSTC, 2011, p. 52). Furthermore, nearly 50% of funds support teacher effectiveness as either a primary or secondary goal (NSTC, 2012). Despite these efforts, and the fact that STEM education includes a wide swath of industry and educational aims, STEM investments comprise less than one percent of total educational spending in the United States (NSTC, 2011).

Inequity and STEM Policy

It is important to note that racial and gender gaps in science, math, and technology proficiency and interest were recognized by federal officials early. In 1980 the Committee on Equal Opportunities in Science and Engineering (CEOSE) was established by the United States
Congress with the passage of the Science and Engineering Equal Opportunities Act (CEOSE, 2017). With an annual budget of over 592 million dollars, this work has resulted in direct funding for research and dissemination of best practices as well as direct funds to support underrepresented student populations to pursue advanced STEM degrees (CEOSE, 2017). The funds primarily target post-secondary and career research projects. All cited success stories involved higher education and mostly graduate level education. This effort seems uneven at best given what we know about career research (Eccles & Wang, 2016; Hackett & Betz, 1981; Lent et al, 2005). Many studies have found even STEM-competent students, particularly females, are not choosing to pursue STEM degrees and careers starting as early as adolescence, due to perceived low self-efficacy and a disconnect between self-identity due to cultural and social influences (Ball et al., 2017; Blickenstaff, 2005; CAWMSET, 2000; Eccles & Wang, 2016; Miller, 2015; Reha, 2009; Williams, 2014; Zeldin et al., 2008). It would seem significant research and investment should be focused on K-12 and undergraduate levels if the goal is to move the needle, a stated goal (NSTC, 2013).

It may be too early to draw conclusions regarding the effectiveness of federal policy at reducing gender and racial gaps in STEM degree and career attainment. Investments K-20 are underway which include afterschool programs, grant programs for SEAs and LEAs, and funds at the university level for additional research to better understand which strategies are most effective (Honey et al., 2014; NRC, 2011). There is anecdotal evidence that some of these efforts are making an impact such as increasing the number of students of color pursuing STEM degrees (CEOSE, 2017). However, much work remains. In fact, between 2000 and 2014 just under ten percent fewer first-year university women indicated they are interested in pursuing a STEM
degree (NCWIT, 2015). This indicator is not promising. States and districts must do more to leverage the funds and research which has been invested over the last several decades.

**Culturally Relevant Pedagogy**

One aspect of Culturally Relevant Pedagogy is Place Based Education (PBE), which is an idea that receives limited attention during teachers’ preservice education or curriculum design (Schmidt, 2011). For example, classroom layout, lesson planning, student access to supplies and materials, safety, and management are all aspects discussed in teacher preparation programs and are referenced in teacher evaluation frameworks (Marzano, 2007). In addition, many teachers now receive training in multi-cultural education and are encouraged to share stories and curriculum that are representative of their diverse student population. However, schools and preparation programs do not generally focus on Lefebvre’s (1991) dimensions of place: conceived, perceived, and lived. Conceived being the abstract conception of the space which encompasses the values and beliefs of the elites, or majority population. The perceived is the abstract conception of the space in the mind of the user. The lived spaces are the concrete locations where people interact with physical configurations of objects and each other (Schmidt, 2011). In education, we typically focus on lived spaces, ignoring students’ and parents’ perceived understanding of space or societies projection of space upon our schools and classrooms (Greenwood, 2009). We do not stop to think that the conceived space does not represent our students that are not part of the dominant cultural majority. We certainly do not think about colonization of a space and its impacts upon native perceptions and interaction with place and those now occupying the place (Greenwood, 2009).

In addition to the factors discussed above, the ability to learn in a space is also greatly impacted by the “single privileged curriculum-as-plan” (Aoki, 1993, p. 258). Packaged
commercial curricula must make it through many hoops and appeal to as many states and districts as possible in order to sell widely and be profitable. Unfortunately, often the people making the decisions about curriculum and its development share a common cultural heritage and perspective. This means that those who control both the planned and lived curricula are often biased towards a white, male, western way of knowing. This results in learning spaces in our classrooms that are most often filtered through a lens that is inaccurate and narrow and which leaves many students at a disadvantage. There is a greater opportunity for dissonance and disengagement for students in which there is a larger gap between the formal curricula and their lived experience in the larger world (Schmidt, 2011).

Regardless of who we are, we have distinct experiences and perspectives. These experiences shape how we understand the world and each other. For example, a White, heterosexual male student has a far greater likelihood of picking up a textbook or hearing an anecdote during a lecture that resonates with his prior experience and background. When educators ensure they take into account their students’ diversity of experience this is what Gloria Ladson-Billings (1992) has coined as culturally relevant teaching (CRT). Geneva Gay (2010) explains it this way saying that CRT “uses the cultural knowledge, prior experiences, frames of reference, and performance types of ethnically diverse students to make learning more relevant and effective” (2010, p. 3).

A related factor that impacts whether students feel the classroom is a place where they are respected and welcome is deficit versus asset thinking. Many teachers in low-income schools take on a savior mentality and regard their students as unfortunates. Freire (1970) would call this false generosity. Instead, teachers must realize that regardless of gender, race, or income all students bring with them a rich compilation of assets (Leonard, 2008). These assets could be
resilience in the face of adversity, the ability to quickly and accurately read people and situations, strong communication skills, or dual-language proficiency, among many others. Instructors instead must design lessons and experiences from the students’ perceived and lived experience. The students must be able to relate to the content and see its relevance in their lives (Ladson-Billings, 1995; Gay, 2010; Blickenstaff, 2005; Reha, 2009; Shapiro & Williams, 2012).

One way educators can actualize these ideals is to make classroom spaces welcoming for all students related to pedagogical and curricular cultural referents. This idea is a consistent theme in Culturally Responsive Mathematics Education (Greer, 2009) and similar texts. This is even true for the areas of mathematics and science. Many argue that mathematics is culturally neutral. However, Greer (2009) demonstrates how examples and language used in the math classroom often favor students from the dominant culture as do Gay (2018) and Ladson-Billings (1995). Teachers and programs which employ CRT practices create spaces for students to be understood and valued. In this way, and for the purposes of this study, PBE is encompassed within CRT.

Afterschool and summer camps can be designed to be relevant to a wider group of students through CRT. For example, some camps are inquiry-based and allow students to design and build their own projects (Varney et al., 2010). This allows students to be in the driver’s seat and has the potential to focus on solving problems that have meaning to them (Gay, 2010). Other opportunities are designed to support a particular demographic, such as underserved student or female students (Dell, Chochester, & Garrick, 2011). Others leverage online learning to promote inquiry (Lazaros & Bormann, 2013) or leverage students’ interest in non-STEM topics to encourage participation (Glackman, 2013; Jones, 2011, 2012; Jones, 2014).
As the U.S. student population becomes more diverse, more and more of our teachers “cannot evoke shared frames of reference to make meaningful connections between classroom instruction and the cultures, lives, and experiences of racially, ethnically, socially, and linguistically different students” (Greer, 2009). In STEM classrooms, this often includes the instructor’s inability to be inclusive of women (Eccles & Wang, 2016; Nasir & Vakil, 2017). Teachers need to work harder to know and understand their students’ unique and different lived experiences and use that knowledge to build culturally relevant experiences. While this is true in all scholastic arenas, it is particularly true in math, science and technology.

**Gender, CRT and STEM**

The fact that math and science in general, and STEM in particular, has been regarded as culturally masculine is well-founded in the literature (Brotman & Moore, 2008; Eccles & Wang, 2016; Williams et al., 2014; Moss-Racusin et al., 2012; Nasir & Vakil, 2017). There is an entire field dedicated to this area of study called feminist technoscience and technofeminism (Iverson & James, 2014; Lykke, 2010; Wajcman, 2004; Wyer, Barbercheck, Cookmeyer, Ozturk, & Wayne, 2014). Wajcman (2004) ascribes this state of reality to political movements from the 1960s and 70s when science and technology became associated with the military-industrial complex which contributed to the “development of technology as a masculine construct” (p. ix). This cultural reality impacts teachers, curriculum and classroom environments. Nasir and Vakil (2017) saw similar results in what they called “gendered cultures” and found “that the culture of STEM itself and spaces in which STEM opportunities are made available often reflect the values, interest, and experiences of the dominate culture and as a result are often unwelcoming” to women and other minority groups (p. 377).
Hughes’ (2001) review of student science identities found that “female access to physical science continues to be a problematic because the construction of a privileged, masculine status for scientific knowledge and pedagogies, reproduces gender segregation” (p. 275-276). On the other hand, biological sciences are more ‘humanized’ and are often situated as feminine or gender-neutral (Harding, 1991; Hughes, 2001). In the study’s conclusion Hughes (2001) emphasized the danger of looking at gender and science in a binary fashion. Instead an anti-essentialist approach is presented. They found that when science classrooms had a constructivist approach including student-led investigations, opportunities arose for the reconfiguration of dominant discourses and made room for more ‘hybrid identities’ (Hughes, 2001). This means that students from underrepresented groups were afforded opportunities that allowed them to see anew what STEM is and who can participate and ‘do’ STEM.

As has been shared in the previous chapter, studies have shown that in general, female students have lower self-efficacy in math and science than do their peers (Shapiro & Williams, 2012; Zeldin et al., 2008). This is true for STEM in K-12 and later in college (Corbett, & Hill, 2015; Shapiro & Williams, 2012; Zeldin et al., 2008). Studies show differences in how students from an early age identify with math and science (Blickenstaff, 2005; NAE, 2008; Williams, 2014; Xie et al., 2015). Boys tend to have more confidence in their abilities and both boys and girls can identify more male examples in STEM fields starting in elementary school (NAE, 2008). While girls perform as well or better than boys in math and science in high school they do not see a correlation between their goals and the STEM profession (Blickenstaff, 2005; Williams, 2014; Xie et al., 2015).

These findings should not be a surprise given the cultural dissonance that female students experience within most STEM classrooms. However, experiences which have been designed to
account for students’ way of knowing including place, their prior lived experiences, and identity have shown promise. In a critical ethnography study of urban youth aged 10 to 14 by Calabrese Barton and Tan (2010) researched the relationship between agency, identity and science learning. The five-week experience centered upon investigating whether the student’s city exhibited what is known as an Urban Heat Island effect. Through observations, video transcripts, and field notes, researchers noticed changes in students’ language, attitude, and self-described identities. The students’ science identities at school and at the camp diverged over the five-week experience. Researchers attributed this change to students “producing” science and being “critical” of science rather than passively reading or walked through pre-determined experiments. By being critical learners, student-researchers experienced a broadening of what it means to do science and be a scientist. This new, broader view included the student’s seeing themselves as scientists rather than scientists being “other” (Calabrese Barton & Tan, 2010).

In a review of two studies by Rahm (2008) in which hybridity and positioning were explored in an after-school science program for urban girls in Quebec, Canadian students changed their outlook on science. By hosting a girls-only club in a neutral location, girls were able to reposition themselves and explore science in a way that was not possible at school. Rahm called this space a “third space or opportunity space [which] made possible the exploration of new possible selves and positions while acknowledging and respecting them for who they are” (p. 117). This was achieved by creating a learning space that integrated the teachers and students’ histories with the current learning activities. The final step was to help students envision possible future STEM selves in a way that honored who they are now (Rahm, 2008). Similar to the findings of Calabrese Barton and Tan (2010), when students saw themselves as insiders, or scientists and engineers that merged aspects of their personal view of the world with the STEM
activities in a holistic way, learning occurred and an expanded view of what it means to be a scientist resulted.

Understanding CRT allows educators to design learning experiences that are meaningful, relevant, and approachable for underrepresented students. CRT also asks educators to include student agency as part of the learning design. When students have choice they are able to pursue, construct, and solve ideas and problems that are relevant to their lived experiences. Based on the literature STEM education and careers are not culturally neutral. If we are to hope to eliminate gender gaps in STEM education and careers school and STEM camp experiences must be culturally relevant for all students. This will ensure that learning environments and spaces are supportive for underrepresented groups, such as females in STEM, which is not currently the case. Next, I will share what the literature says about how educators can build the confidence, or self-efficacy, of students to pursue STEM opportunities and increase STEM career interests.

Social Cognitive Theory and Career Theory will be discussed and related to the STEM literature.

**Social Cognitive Theory and Social Cognitive Career Theory and STEM**

Self-Efficacy is situated in Social Cognitive Theory (SCT) within the field of psychology. Albert Bandura coined this term in his second book where he emphasized the cognitive nature of human behavior which he demonstrated is caused by personal, behavioral, and environmental influences (Bandura, 1986). This built upon his well know Bobo Doll experiments which demonstrated the link between changes in childrens’ behavior after observing modeled behavior (Hock, 2009). These experiments built upon Miller and Dollard’s (1941) research and contributed to his seminal book, *Social Learning Theory* (Bandura, 1977; Evans, 1989). In this work Bandura showed a direct relationship to self-efficacy and behavioral change (Bandura, 1977).
Bandura explains that the self-efficacy comes from four sources: “performance accomplishments, vicarious experiences, verbal persuasion, and physiological states” (1977, p. 191). Using Bandura’s well known and cited psychological construct for self-efficacy we can better understand the factors that impact student self-efficacy. Velthuis, Fisser, and Pieters (2015) describe these factors in more detail.

Mastery experiences are the most effective way of creating a high feeling of self-efficacy, and the more successful the experience, the more likely it is that one will repeat or extend that behavior. Vicarious experiences, which are observed examples or experiences undergone by others who are similar to oneself, can also increase the sense of efficacy: “if they can do it, I can, too.” The third source of information that influences people’s beliefs that they have what it takes to succeed is what Bandura called social persuasion, or being persuaded verbally by others that one possesses the capabilities to master given activities. The final source of information that can increase self-efficacy is a reduction in people’s stress reactions, which has to do with physical and psychological aspects and how these aspects are perceived and interpreted. An individual’s mood affects his or her judgments of self-efficacy (p. 218).

Each of these four sources of information impact a person’s self-efficacy. However, it is important to note that context, the task itself (e.g. degree of perceived difficulty), and the person’s existing self-efficacy all play a role in how the information contributes or detracts from a person’s self-efficacy (Mulholland & Wallace, 2001). These ideas challenged conventional, behaviorist thinking (Hock, 2009). Instead of being either autonomous with regards to one’s actions or subject wholly to one’s environment, Bandura (1989) argued that people “make causal
contribution to their own motivation and action within a system of triadic reciprocal causation: action, cognitive affective, and other personal factors and environmental events which all operate as interacting determinants” (p. 1175).

A basic tenant of SCT is that people are more likely to engage in an activity if they believe they can master it as opposed to an anticipation of failure. Students’ perceptions of their abilities can be powerful in motivating them to try something new, see a task or challenge to completion, or bounce back from failure. In addition, students who are successful initially may work harder in subsequent attempts and thus strengthen their belief that they are capable (Bandura, 1986, 1989).

In addition to education, more current research regarding SCT and self-efficacy has centered on how these ideas can be applied to media, mass communication, and health (Bandura, 2001). Studies have used SCT as a theoretical framework to explain and predict impacts of repeated visual messages (Nabi & Clark, 2008). SCT has been used as a construct to improve health by reducing unwanted behaviors as well (Bandura, 2004; Martino, Collins, Kanouse, Elliott, & Berry, 2005). Next, I will discuss how self-efficacy has been used as a construct to understand and explain female confidence in STEM. As discussed above, given the cultural dissonance that many females feel with regards to STEM subjects and careers, it is helpful to leverage SCT to better understand how educators can create experiences that positively impact how female students STEM identities.

Self-Efficacy, Females, and STEM

Studies have shown that in general, female students have lower self-efficacy in math and science than do their peers (Shapiro & Williams, 2012; Zeldin et al., 2008). This is true for STEM in general and later in college (Corbett, & Hill, 2015; Shapiro & Williams, 2012; Zeldin
et al., 2008). Many theories have been published but researcher consensus focuses on social and cultural forces (CAWMSET, 2000; Corbett, & Hill, 2015; Shapiro & Williams; 2012 Williams, 2014; Xie, Fang, & Shauman, 2015).

The social and cultural forces have been tied to family (Reha, 2009), implicit bias (Xie et al., 2015), cultural influences (Calabrese-Barton & Tan, 2010; Miller, 2015; Reha, 2009), lack of role models (CAWMSET, 2000; Zirkel, 2002), lack of career information or knowledge (Reha, 2009; Williams, 2014), and low teacher self-efficacy and inadequate training (Honey et al., 2014; Miller, 2015; NRC, 2013). However, studies have shown that even short-term interventions had positive impacts upon student STEM interest and self-efficacy.

In a study by Nugent, Barker, Grandgenett, and Adamchuk (2010), situated in a diverse middle school during the summer break, almost 300 youth participated in a STEM camp. Using a quantitative design, the project included two treatment groups and one control group. The full-treatment group participated in a weeklong, 40-hour STEM camp. The short-term intervention group consisted of 141 students who participated in a three-hour STEM event. Students that participated in the weeklong camp demonstrated increased learning based on a content assessment measuring C.S., mathematics, geospatial technologies, and engineering (Nugent et al., 2010). Student participants from both the full and short-term intervention groups showed increases on the self-efficacy scale, both significantly higher than the control group (Nugent et al., 2010). This study suggests that even short-term interventions, which include mastery experiences, can have positive impacts upon students’ self-efficacy.

In a very different intervention, eighth-grade girls from a science class were invited to a nearby college campus (Williams, 2014). While there, they were exposed to several engineering careers through lectures and projects. At the conclusion, 40% said they would like to study
engineering in college while 83% said they were interested in taking an engineering class. The following year nine students enrolled in an engineering class, the prior year only one female student was enrolled, and 18 enrolled in drafting (NAPE, 2012). This study indicated that exposure to career pathways and simply observing, or what Bandura (1997) calls, vicarious experiences, can have positive impacts upon student’s interest and decision-making.

Studies have been instructive regarding how to improve young female students’ self-efficacy. In Holland’s (2004) study of fifth-graders using LEGO™ robotics technology promising results were reported. Students learned about robots using a pre-developed curriculum. Using a mixed-methods design, students’ attitudes and perceptions of robots were measured using pre- and post-assessments. At the conclusion of the study, girls’ self-confidence was more positive than boys’ self-confidence while the pre-test data had the opposite findings (Holland, 2004). Though it appears female students’ self-efficacy can be strengthened, for girls to persist and choose to pursue STEM degrees and careers they must feel STEM careers align to who they are as individuals (Gay, 2018; Greer, 2009; Ladson-Billings, 1995, 2009; Leonard, 2008).

**Self-efficacy, Identity, and STEM**

From an early age, studies show difference in how students identify with math and science. Boys tend to have more confidence in their abilities and both boys and girls can identify more male examples in STEM fields starting in elementary school (NAE, 2008). While girls perform as well or better than boys in math and science in high school they do not see a correlation between their goals and the STEM profession (Blickenstaff, 2005; Williams, 2014; Xie et al., 2015). For this reason, researchers have theorized this is a major reason why the gaps in the social and biological sciences have closed while gaps in the hard sciences such as physics,
biology, C.S. and engineering have remained or even widened (Ball et al., 2017; NCWIT, 2015; Wang & Degol, 2017; Xie et al., 2015).

Not all girls are able to envision themselves as scientists or engineers (Sjøberg & Schreiner, 2007). Archer et al. (2013) found in their longitudinal study spanning five years that girls’ understanding of science related careers did not fit with their self-identification as feminine, typical, caring or active. Ten-thousand girls ranging in age from ten to fourteen participated in this study situated in England. Others have confirmed this finding (Corbett & Hill, 2015). Similar results regarding identity dissonance were found for mathematics (Fennema & Peterson, 1985; Mendick, 2005). As evidenced by one research participant in the study by Archer et al. (2010), female role models were largely absent and instead girls reported role models in other fields, “I’ve got loads of role models that are actresses” (p. 179).

In a mixed-methods study conducted by the National Academy of Engineering entitled Changing the Conversation (NAE, 2008) similar results were found. They conducted in-depth interviews of youth triads aged nine to eleven and interviewed focus groups of parents and engineers. To verify these findings a quantitative instrument was used in the form of a survey of 3,600 individuals. They found that girls were half as likely to believe engineering could be a rewarding career choice or that it would have a positive effect on people’s lives. Both boys and girls could name males in STEM careers but almost none could name a female (NAE, 2008). In addition, they found that engineering and computing careers in general did not help solve community problems, were not social, and did not involve teamwork (NAE, 2008). This finding was more pronounced for African American girls and Latina students in the study. Yet in broad terms, we know that “women are more likely than men to prioritize helping and working with other people over other career goals” (Corbett & Hill, 2015, p. 4). Others have found similar
results regarding a female preference for jobs with a clear social purpose (Eccles, 2007; Margolis, Fisher, & Miller, 2002). This is true even for young girls between the ages of ten to fifteen (Weisgram, Bigler & Liben, 2010). However, studies have shown this disconnect can be positively changed if girls are given the opportunity to understand the connections between their identities and STEM careers (Diekman, Clark, Johnston, Brown, & Steinberg, 2011).

So what can be done to help young women make a concrete connection between their identities, career interests and STEM occupations? In a study by Shapiro et al. (2015) 1,200 students aged ten to fifteen, and from across the northeast portion of the United States, were surveyed. Demographically the study sample population closely resembled the larger population. Shapiro et al. (2015) suggest that schools and parents can help students make these connections by emphasizing the relational aspect of STEM jobs and by providing concrete examples of how these roles help others. They go on to say those working with young female students should have direct conversations about these careers otherwise “their knowledge tends to be limited and prone to stereotypes” (Shapiro et al., 2015, p. 11-12). Archer et al. (2013) gave similar recommendations in their study. And again, In Solving the Equation (Corbett, & Hill, 2015) the authors recommended that schools “showcase” how STEM careers align with outcomes that are socially beneficial (p. 3). Other beneficial interventions include providing single sex programs (Shapiro et al., 2015), career days, and providing STEM during the day (Miller, 2015; Reha 2009). In addition, providing role models who have explicit conversations about women in STEM and who emphasize effort over intelligence is critical (Reha, 2009; Shapiro et al., 2015). For these connections to be made, young women need access to STEM opportunities and experiences.
Science is a critical and often underdeveloped component of STEM in K-12 education (Miller, 2015; NRC, 2011, 2013; Reha, 2009). In Miller’s (2015) mixed-methods study of STEM integration at the upper elementary level both teacher efficacy regarding science and a lack of Opportunity to Learn (OTL) science were found to be common across three K-5 schools, fifteen teachers, and nearly 400 students. Approximately 50% of students were considered low-income. Miller (2015) found that students did not perceive science as useful as math. While students, especially female students, had an interest in pursuing careers involving creativity, “their perception of science as useful or important to their future careers was low” (Miller, 2015, p. 172). It is important for teachers to go beyond math and science proficiency. Schools must ensure that young women see math and science and associated occupations as interesting (Reha, 2009). Researchers were clear that these interventions need to start at a young age (Calabrese Barton & Tan, 2010; Linver, Davis-Kean, & Eccles, 2002).

**Social Cognitive Career Theory and Self-Efficacy**

If the ultimate goal is to achieve equality in career attainment in STEM career fields, we must understand the processes by which one chooses a career. As discussed above, self-efficacy has an instrumental role in influencing adolescents’ STEM career intent. Social Cognitive Career Theory (SCCT) introduced by Lent, Brown, and Hackett (Lent et al., 1994, 2005,) is a “useful theoretical lens to understand the mitigating factors that lead to STEM career intent and the unique situation that underrepresented groups are in with respect to their career choice” (Wagstaff, 2014, p. 46). The SCCT framework builds upon Bandura’s (1971, 1986) Social Cognitive Theory (SCT) discussed above and has three interrelated models including career interest and awareness, academic and career choice making, and performance and persistence
The framework helps explain how these three constructs relate to both personal and contextual factors.

**Career Interest and Awareness**

The first model, the researchers explain, builds upon SCT and articulates how career interests and awareness develop. They explain that the process begins in early childhood as students are exposed to an array of activities which have a potential for career relevance. Young people also observe others perform various occupational tasks (Lent et al., 1994). This exposure is varied and differentially reinforced. “Through repeated activity engagement, modeling, and feedback from important others, children and adolescents refine their skills, and develop personal performance standards, form a sense of efficacy in particular tasks, and acquire certain expectations about the outcomes of their performance” (Lent et al., 1994, p. 89). These experiences lead to initial interests which lead to goal setting and further experience which increases the likelihood of future task selection and practice and either successes or failures impacting underlying self-efficacy (Bandura, 1989; Lent et al., 1994). In late adolescence and early adulthood, career identity crystalizes and it becomes less likely that an individual will change their career interest (Bandura, 1977, 1986; Erikson, 1968; Lent et al., 1994). For this reason, it is important to help students have varied and positive experiences within the STEM arena. This will support self-efficacy, interest, and awareness in STEM opportunities in future years (Bandura, 1989; Lent et al., 2005, 1994; Wagstaff, 2014).

**Career Choice Making**

This model builds upon the former in a developmental way in that it is an extension of interest formation. It has three components. First, there is a selection of a primary career goal from among all of the individual’s career interests. Second are actions which support and help
implement the career choice such as enrollment in an apprentice or certificate program or taking a course in high school (e.g. signing up for a computer club, C.S. elective, foreign language, or DECA). The third component relates to performance outcomes and subsequent success or failure which provide a feedback loop and help influence future career behavior (Bandura, 2004; Lent et al., 1994).

**Model of Performance and Persistence**

This model includes both performance outcomes and persistence over time (Lent et al., 1994). In line with Bandura’s (1986) theory, the authors contend that, “self-efficacy asserts a direct effect on performance (by virtue of its role in helping people to organize and orchestrate their skills)” (Lent et al., 1994, p. 98). As an example, a student who selects engineering as a major (choice goal) also forms goals regarding their grade performance in required courses (performance goal) and how much time to spend reading and studying (persistence goal). It is helpful to think of performance goals as intermediary goals and akin to goal setting. This model assumes the student has prerequisite knowledge, skills, or the ability to attain them. We know that female students have these skills in math and science at similar or higher levels than do boys (Blickenstaff, 2005; Williams, 2014; Xie et al., 2015).

SCCT states that people must interact, engage, and be exposed to activities or experience in order to develop an interest in them. “As it relates to career choice, this model suggests that young people choose a career over a period of time where they engage in specific career related activities, are able to see themselves in that career, and then begin to make plans to pursue it” (Wagstaff, 2014, p. 38). In recent years the framework has evolved to include applications to STEM and underrepresented groups’ pursuit of math and science related careers. For example, in a study of middle school youth in three cities spanning a wide range of SES and ethnic
demographics, Shapiro et al. (2015) found using a survey that both boys and girls indicated girls were less interested in STEM careers by sixth and seventh grade. Only 12.4% of girls chose a future career in STEM. However, girls who participated in a single-sex leadership opportunity were less likely than boys and non-participating girls to agree that boys have more career opportunities than girls and said that you can do anything if you work hard at it. Finally, participating girls were a third more likely than non-participating girls to choose a STEM career (Shapiro et al., 2015).

However, in order to overcome the gendered nature of STEM subjects and career pathways, we must help underrepresented groups see STEM as culturally relevant to their lived experience. SCCT speaks to critical experiences which will help young people increase their interest and influence their career choice making decision, however, if these experiences are not culturally relevant and speak to the individual identities of women and people of color, then gaps in interest, participation, career pursuit and attainment will continue. Interventions must take into account the individuals’ identities and lived experiences. Camp designers should leverage what we know about career development using SCCT and embed CRT to ensure experiences are equitably effective for each participant. Below a review of prior strategies and their impacts will be shared. These strategies vary in their ability to create experiences that support career identity development and CRT.

A Review of School-Based STEM Strategies

While curricula can be a highly debated, and at times an emotional subject (see Loveless, 2001; Ravitch, 2004), in the realm K-12 education its meaning is somewhat more narrow when compared with the field of curriculum studies. Practitioners are more likely to hold to curriculum’s Latin root meaning of a race course, or course of study (Connelly & Clandinin,
Theorists however take a broader view. In addition to the course of study and books and materials used, teachers, students, classroom and environment, as well as prior and anticipated future experiences are all part of the curricula. It is not only these elements in sum but the synergy, or interaction, of them together that encompasses what is understood to be curriculum (Clandinin & Connelly, 1992).

Many states and districts have been paying attention and have started to develop more and diverse curricular opportunities for their students to gain awareness of, and competency in, STEM knowledge, skills, and beliefs (NRC, 2011, 2012; OSPI, 2016). These opportunities fall into three broad categories and include enrichment or extra-curricular opportunities, specialty or STEM focused schools, and integration and place-based education (Honey et al., 2014; NRC, 2011). While some studies lead us to believe that practices that are effective in STEM education are related to effective practices in general, some strategies seem to be unique to STEM knowledge attainment (NRC, 2011). Below, promising practices within the three categories described above will be outlined.

**Enrichment Opportunities**

Enrichment opportunities come in many forms and often have less barriers to implementation than other strategies. Enrichment can take the form of an afterschool club, a summer camp, or a one-time science night event. They can be less expensive and easier to plan for than what is required for traditional curricular adoptions, course development, or the formation of STEM schools. For these reasons, “afterschool programs are increasingly recognized as playing a valuable role in improving science, technology, engineering, and mathematics education” (Krishnamurthi, Bevan, Coulon, & Rinehard, 2013, p. 5). Studies have
shown positive impacts for students participating in these opportunities, however, all experiences are not equal.

Afterschool enrichment camps and summer camps have also been suggested as a cause of increased disparity between students from low and high SES families due to cost and other barriers (Xie et al., 2015). However, these “results are confounded by the fact that high SES students are more likely to matriculate and complete college” (Xie et al., 2015, p. 338). When researchers use multivariate analysis differences in students’ interest and persistence in STEM are eliminated when factors such as academic achievement are controlled for (Chen & Soldner, 2013; Xie, 2012). Therefore, recent research suggests that while SES plays a role in students’ academic skill attainment, it does not directly impact STEM interest, pursuit, or attainment (Xie et al., 2015). As has been discussed above, girls are performing as well or better than their male counterparts in traditional academic subjects of math and science in high school and on SAT tests.

Afterschool programs that yielded positive gains focused on improving STEM attitudes and awareness first followed by increased STEM knowledge and skills second (Afterschool Alliance, 2011). In addition, successful programs often incorporate parent involvement components (Reha, 2009). A focus on teacher professional development and training is also a common component of afterschool clubs and camps showing positive student impacts among student attitudes and course taking (NRC, 2013).

Another component of successful clubs and camps included hands-on experiences with technology guided by trained staff which often served as mentors. This was true in a study by Varney et al. (2012) which explored the impact of an elementary summer camp focusing on engineering using LEGO™ robotics. The students had autonomy to design and build their own
STEM projects. The program supported 128 students on average over several years and was so successful it was moved to an in-school program. Study participants demonstrated higher average academic and citizenship grades (Varney et al., 2012).

The duration of these opportunities has also been explored. Given limited funding it is not surprising that schools and districts want to know more about how time impacts student achievement and interest in pursuing STEM courses and later degrees and careers. A study designed by Nugent, Barker, Grandgenett, and Admachuk (2010) compared student achievement and interest between a 40-hour summer camp and a three-hour evening event. Not surprisingly, student achievement and content knowledge were reported only for students participating in the longer summer camp, however, interest in STEM improved for both groups (Nugen, Baker, Grandgenett, & Admachuk, 2010). This finding is instructive depending upon program goals and funding parameters. As STEM education has grown in popularity so too has interest in schools focused on STEM.

**Specialty Schools**

While magnet, or in-district themed schools focusing on science and mathematics have been around since the 1970s STEM-focused charter schools have developed in more recent decades (Judson, 2014; NRC, 2011; Robelen, 2011). In Monitoring Progress Toward Successful K-12 STEM Education (NRC, 2013) authors recommend districts consider development and implementation of three “models of STEM-focused schools” (p. 13). These include STEM-focused choice schools, career and technical education programs, and comprehensive public schools. We know that students that attend STEM-focused secondary schools are more likely to take more rigorous STEM courses (Subotnik, Tai, Rickoff, & Almarode, 2010) and about twice
as likely to complete STEM college degrees (Thomas, 2000). Yet, in an earlier study the NRC authors cautioned readers regarding making causal judgments based on current research:

Because of the challenges with conducting causal research on these schools, little research is available that demonstrates the effectiveness of STEM-focused schools in comparison with other schools or that contrasts the relative effectiveness of their different approaches on a variety of student outcomes (NRC, 2011, p. 25).

In an attempt to determine if STEM schools do have a direct impact, Judson (2014) designed a study that looked at students that transferred to both magnet and charter schools and compared them with traditional district transfer students. Student data was monitored for four years. Students were included if they transferred and remained at the STEM school for three years. Comparison students transferred to non-STEM schools within the same districts. Student academic results were compared using statistical analysis in their final year. There was an overall null effect for students attending STEM-Magnet schools when compared to comparison schools. Authors saw a small, but statistically significant increase in student achievement when compared to the control population in some years but not others. The mixed results across all school types may mean the instructional strategies and teacher actions and beliefs are more influential than being designated a “STEM” school (DeJarnette, 2012; Judson, 2014; NRC, 2011). So while students attending STEM schools do pursue and gain STEM degrees at higher rates than traditional schools, this is due to STEM interested students transferring to these schools. When other factors are accounted for, similar students at traditional high schools follow similar course taking patterns and attain STEM degrees at the same rates (Judson, 2014).

STEM-school instructional strategies varied across schools with no unifying instructional strategies other than science course taking patterns. Some schools appeared STEM in name only.
The term seemed to be aspirational in nature while others provided afterschool clubs and access to technology (Judson, 2014; NRC, 2013). More research is needed to determine if the investments in STEM specialty schools are worth the investment of time and money. While specialty STEM schools remain popular studies discussing the integration of STEM across subjects and within classes and programs is even more common.

**Integration and Opportunity to Learn Science**

While some studies show that enrichment and STEM schools show promise in increasing students’ awareness, interest, and competency in STEM subjects and careers, there is a robust call for integrating STEM into the elementary school day (NRC, 2011, 2012) The NRC states that, “ideally, STEM curricula should be aligned across disciplines from grade K-12” (NRC, 2011, p. 27). Based on their study of successful undergraduate students pursing STEM degrees Russell, Hancock and McCullogh (2007), noted that, “the best time to create a connection, awareness and interest in STEM fields would be the elementary years” (p. 78). One initiative where this is made very clear is in the creation and dissemination of the Next Generation Science Standards (NGSS).

The structure of these standards is organized around three areas: concepts, engineering practices, and core ideas. This integration of engineering practices is new and a strongly emphasize attribute of the standards (NGSS, 2013). Almost every discipline has taken on the mantel of integrating STEM, including the arts in the form of STEAM (Jones, 2011). You can even find evidence of integration into gym class (Jones, 2011). In addition to integrating STEM into science and other content areas, students need adequate time to learn science content itself.

Science is a critical and often underdeveloped component of STEM in K-12 education (Miller, 2015; NRC, 2011, 2013; Reha, 2009). In Miller’s (2015) mixed methods study of STEM
integration at the upper elementary level both teacher efficacy regarding science and a lack of Opportunity to Learn (OTL) science were found to be common across three K-5 schools, fifteen teachers, and nearly 400 students. Approximately 50% of students were considered low-income. Schools must increase their focus and time on science to increase what Archer et al. (2013) call students’ science capital. The NRC (2011) has called for an increase in quality and quantity of science instruction in the early grades and an equal emphasis on assessment and accountability when compared with English language arts and mathematics.

However, integration alone may not be enough. In a study commissioned by the National Academy of Sciences (Honey et al., 2014), authors reviewed STEM studies that focused on integration. The focus was on both academic outcomes and improving identity and interest in STEM. Overall, there were few robust studies. In the studies reviewed, results were mixed although those focusing on identity and interest were promising (Honey et al., 2014).

**Common Curricular and Instructional Strategies**

In summary, effective instruction in STEM at the elementary is engaging and builds upon student knowledge and interests (DeJarnette, 2012; NRC, 2013; Reha, 2009). Strong leadership and teacher self-efficacy are critical attributes of successful STEM schools and programs (Miller, 2015; NRC, 2011). Students also need sufficient time learning science and quality curriculum addressing science, technology, engineering, and mathematics standards (Miller, 2015; NRC, 2011).

In addition to additional focus and time, relevance is key to maintaining female interest in science and mathematics. This can be achieved through increased hands-on science during the day (Maltese & Tai, 2010) and after school and camps for girls (Frost & Wiest, 2007). Another contributing factor identified in the literature was related to teacher efficacy. In Miller’s study
(2015) it was found that teachers’ personal efficacy was higher in math than science. She also found that teacher awareness and knowledge of STEM careers was low and that that teachers did not have “purposeful discussions of careers in general” (p. 106). In another study Beghetto & Baxter (2012) investigated the association among 276 elementary students’ science and math beliefs and teachers’ confidence in mathematical and science understanding. A positive correlation was found with regards to student risk-taking and student self-efficacy in science. A similar study of 302 students and 613 teachers (Ghanbarlou, Masoud, & Ejei, 2015) found a correlation between teachers’ academic optimism and students’ academic achievement. This correlation was found to be true for learning-disabled students as well (Levi et al., 2013). To support teachers in preservice, induction programs, and ongoing professional development, efforts must place a greater emphasis on science instruction. STEM camps and clubs can serve as low-pressure environments for teachers to experiment and become more confident in their ability to teach STEM content. Quality curriculum and a coherent sequence are also essential tools to support both learning and instruction (NRC, 2011, 213). In addition to hands-on, student-driven, integrated curriculum taught by confident and equipped teachers, students must see the relevance of the curriculum to their own lived experience (Gay, 2018).

Culturally Responsive Pedagogy and connections to careers, goal setting, and persistence were not typically focal points of the school-based STEM strategies reviewed. When these features were discussed, they were typically part of after school or summer clubs and camps with a goal of serving under represented youth (Calabrese Barton & Tan, 2010; CAWMSET, 2000). Without the pressure of standardized assessments camps and clubs were more often inquiry-based allowing students to explore topics of interest to them. These camps and clubs also provided more exposure to STEM career examples and exploration (Calabrese Barton & Tan,
In addition, these camps and clubs were more often designed to allow students to determine the focus of the day-to-day activities as well as the overall aims of the experience (Varney et al., 2012). These are key components to CRT (Gay, 2018). Because the camps where more likely situated in the students’ own communities and inquiry-driven, students were more likely to have experience that connected with their own interests and past experiences (Calabrese Barton & Tan, 2010; Gay, 2018; Rahm, 2008; Varney et al., 2012). This helped students to connect with STEM disciplines and careers in a more personal way.

STEM schools and STEM integration into the school day tended to focus on exposing students to rigorous STEM coursework. However, curricula and instruction were often secondary to a focus on placing students into traditional science and math classrooms such as higher-level math and science calculus and physics courses. While hands-on experiences were mentioned within the integration literature, providing opportunities that were student-driven and culturally relevant were notably absent. In fact, some see STEM schools as elitist and adding to the current gender and racial gaps in STEM education and attainment (Nasir & Vakil, 2017).

Conclusion

Currently, the United States does not adequately prepare enough students for the twenty-first century workforce. Some students do not have the opportunity to pursue STEM degrees because they are not adequately prepared. Many others, particularly female students and students of color are choosing not to pursue STEM careers or degrees (Bureau of Labor Statistics, 2014; College Board, 2013; NCWIT, 2016). In fact, between 2000 and 2014 seven percent fewer first year university women indicated they are interested in pursuing a STEM degree (NCWIT, 2015).
Some would say we’re going backwards. We must help young students make connections between their passions and talents and STEM careers.

To ensure all students leave K-12 prepared to pursue STEM opportunities school and community leaders must work together to overcome the challenges discussed here. We must help all girls see the relevance of STEM. To do this, students who have been historically underrepresented must be given opportunities to see and experience STEM activities in action and in a way that is aligned with their interests and passions. We must break down stereotypes about STEM so they can see that STEM careers do align with their goals, abilities, and self-identity. We must provide young students the opportunity to learn science in ways that are engaging, hands-on, student-interest driven, build upon students’ ways of knowing, and that are culturally relevant starting in kindergarten (Gay, 2018). We must leverage what we know about career identity development to create experiences that provide opportunities for women and other underrepresented groups the opportunity to gain confidence and self-efficacy through culturally relevant tasks and scenarios with role models that look like and understand them. We must better involve parents and support teachers in the STEM education of their students. Principals and school leaders must understand this challenge and bring stakeholders together to meet this very real challenge. Our very economic competitiveness as a country depends upon our success. As President Obama pointed out during a White House-sponsored science event addressing our shortage of women in STEM fields, “half our team, we’re not even putting on the field. We’ve got to change those numbers” (Corbett & Hill, 2014, p. ix). We can and must do better.

Most research attempting to answer the programmatic impacts of science and STEM initiatives focus at the middle or high school level (DeJarnette, 2012; NRC, 2013). We know that students start making decisions related to their future and how they see themselves in relation
science and various career clusters much earlier (Linver, Davis-Kean, & Eccles, 2002; Weisgram, Bigler & Liben, 2010). Research studying the impacts of STEM experiences for all preadolescent females during and after the traditional school day is needed. Additional research is needed to explore the unique intersectionality of gender and race and STEM. However, first we must better understand the foundational issues impacting all young women from pursuing and thriving in the STEM workforce.
CHAPTER THREE: RESEARCH METHOD

The United States K-20 education system does not adequately prepare students for the twenty-first century and therefore many students do not have the opportunity to pursue STEM degrees. Many others, particularly female students and students of color are choosing to not pursue STEM careers even though they are academically able (Bureau of Labor Statistics, 2014; College Board, 2013; NCWIT, 2016). In fact, between 2000 and 2014 seven percent fewer first year university women indicated they are interested in pursuing a STEM degree (NCWIT, 2015).

The overall purpose of the study was to contribute to the literature regarding how STEM experiences affect preadolescent female students. More specifically, the purpose was to better understand the experience of female fourth, fifth, and sixth grade students at a summer STEM camp and how those experiences might impact their interest in STEM subjects and careers. Few studies have focused on the intersection of gender, STEM, and preadolescent youth. Furthermore, few if any focused on the persistence of new or changed STEM attitudes and beliefs following STEM experiences. The design of this study allowed for data collection at several points over time including six to eight weeks after the STEM experience concluded.

The study asked, how did fourth and fifth grade female elementary students experience a summer one- to four-week STEM camp? How did their self-perception change in relation to STEM subjects and careers as they attended a summer STEM camp and shortly following?

1. What are the views and perceptions about STEM subjects and careers held by female preadolescent students at the fourth, fifth, and sixth grade levels at a STEM camp?

2. What are perceptions about STEM subjects, careers, and instruction held by female instructors of the fourth, fifth, and sixth grade level participants at a summer STEM camp?
3. How did preadolescent students’ attitudes and perceptions change regarding career aspirations and interest in STEM subjects, courses, and clubs?

In this chapter, I outline the research design used for the study. Researcher positionality, the proposed study setting, participant selection, and data collection and analysis methods are also outlined. Finally, strategies which support the ethics and trustworthiness of the study are shared.

**Method: Qualitative-Convergent Parallel Design**

This study employed a qualitative design. The research questions sought to understand inductively how a one- to four-week STEM camp impacted preadolescent girls’ self-perception and interest in STEM academics and career interest. This study has an interpretive perspective with the view that knowledge is socially constructed from our unique vantage points based on our prior histories, interactions, and experiences (Meriam & Tisdell, 2016). Rather than quantify these influences I sought to parse out and better understand the nuances that influence students’ interest and self-efficacy of STEM subjects and careers. How do the participants interpret and find meaning from their experiences? Through in-depth interviews, observation, surveys, and data collection and a review of the quality of these influences was explored as they are related to career identity through SCCT as reinforced through STEM-related CRT. Additionally, to what extent were the experiences culturally relevant to the student participants through their own eyes and those of their instructors? In this study the researcher was the primary instrument trying to uncover, and then in an ethical and trustworthy way, describe the lived realities of the research participants.

While this study employed a qualitative design, a survey instrument was used in addition to the qualitative data sources discussed above. The survey data served to provide additional
detail and insight to the qualitative data while also reducing the weaknesses and bias inherent when either quantitative or qualitative methods are used alone (Creswell, 2014). Given the participants’ young age, it was important to include an instrument which had been field-tested and validated. Convergent parallel mixed methods is “a form of mixed-methods design in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem” (Creswell, 2014, p. 15). In this approach, the researcher typically collects the data at roughly the same time and then integrates the data in the interpretation of the overall results (Merriam & Tisdell, 2016). Accordingly, interview, observational, and survey data was integrated by theme which emerged from the Descriptive, In Vivo, and Magnitude Coding process which is described in more detail below.

**Researcher Positionality**

At the time of the study, my role was to lead the elementary instructional programs department including K-6 curriculum and instruction, fitness and health, library, music, art, band and strings, STEM, PBIS, and summer and after school programs. I also served on the Chief Academic Officer’s leadership team, which was responsible for principal professional learning and setting the vision and direction of teaching and learning. As a former teacher and current employee of the same district I was conscious of my insider status (Merriam & Tisdell, 2016). Additionally, in my role as director of curriculum and instruction I had to be cognizant of my formal authority and its influence on participants’ willingness to be open and candid. I undertook several strategies to minimize potential bias and the potentially negative impacts of my positionality.

At the outset of the study, I was clear in the consent form that participation was completely voluntary, and that no information would be shared with other camp participants,
their supervisor or other colleagues. I shared strategies, such as the use of pseudonyms, that were employed that ensured their anonymity. In addition, I utilized a reflexivity journal throughout the data collection and analysis phases of the study (Furman, 2012; Seidman, 2013). I explored issues of positionality and bias to support trustworthiness. I used multiple sources, ten interview participants, to triangulate the data. Three types of data sources were used including interview transcripts, observations, and survey data. Finally, extensive engagement with the data took place to reach saturation.

**Setting of the Study**

The setting for the study was at a preschool through eighth-grade summer STEM camp. The site was hosted by a middle school serving a semi-urban community and offered dozens of sessions over four days. Camps ran from 8:00 a.m. to 1:00 p.m. daily and were repeated and offered over a four-week period. Some students repeated sessions or attended different sessions over the four-week period. Each session included the following curricular resources: A PowerPoint with goals, tasks, vocabulary, and career connections. Some camps included a science notebook which had graphic organizers to support knowledge acquisition through non-linguistic representation of text. Each day started with a mini-lesson and review of previous content. Next, students began working on their projects or tasks individually, in pairs, or small groups depending on the session goals or task for that day. Instructors would periodically pull the whole group together to address misconceptions or to teach additional concepts, facts, or skills. In between these mini-lessons instructors helped individual students as needed. Typically sessions ended with a review of the day’s work and a preview of what to expect for the following day. Scheduled breaks and lunch were also interspersed throughout the session each day.
The STEM sessions fell into the three broad STEM content categories: computer science, biomedical science, and engineering. The camps were started five years ago to increase student exposure and interest in STEM courses later in their academic career in middle and high school and STEM majors and careers after high school. Female participation emerged as a concern when I was assigned program oversite three years ago and analyzed the data. We have improved female participation, from a low of 23% to roughly 42% from 2014 to 2017.

The STEM camp was situated in Spokane Public Schools in the city of Spokane, Washington. Spokane Public Schools is a moderately large organization with more than four thousand employees. The district was organized into three divisions: School Support Services, Human Resources Services, and Teaching and Learning Services. At the time, there were thirty-five elementary schools, six middle schools, and five comprehensive high schools. SPS also had several choice schools and oversaw two charter schools all of which served an urban and suburban population (SPS, 2018).

Unfortunately, district staff did not reflect the diversity of the students we serve. This was partly due to the more recent shift in demographics state-wide. The percentage of students of color increased more than twenty percent since 1999 in the district (OSPI, 2017). District leadership had actively worked to address this discrepancy; however, the impediments were significant. The percent of the student population that qualified for free and reduced-price meals was approximately 55. That represented an increase of more than 10 percentage points from 1999 to 2016. During that same period the number of students qualifying for special education services increased by more than 60 percent from 10.5% to 16.8% (OSPI, 2018).

Beginning in 2012 a review of relevant research was conducted by the district’s teaching and learning department. Using a Georgetown study (Carnevale, Smith, & Melton, 2011) as its
foundation, the district chose three main STEM pathways: computer science, bio-medical, and engineering. Career and Technical education courses and electives were aligned to these pathways at the middle and high school levels. Starting in 2014, extra-curricular STEM pilots were started along with summer STEM camp. The extra-curricular offerings occurred after school for six to ten weeks and focused on the same three STEM pathways. The summer STEM camp started with several hundred and grew to approximately 2000 students in 2017. Offerings at the summer STEM camp also focused on the three pathways. In 2017, a science adoption was launched to review and acquire core curriculum that aligns with the NGSS, including engineering, with a goal to embed the pathways into the school day and increase access and equity.

As a medium-sized urban district Spokane Public Schools had a diverse constituency. The local union was very active and uniquely represented all unionized groups. In addition to contract negotiations the union leadership met weekly with district staff to discuss and problem-solve issues that either party wanted to resolve. The city of Spokane and many of its departments were key stakeholders including the parks, fire, police departments, and city administration. They worked together regarding safety, land use and acquisition, and policy. They had agreements with dozens and dozens of local non-profits and non-governmental organizations. These organizations had similar missions to help serve the youth of Spokane. In some cases, they could provide services the district could not and in others they helped augment district programs. The Board of Directors for SPS set the direction of the system through the district’s strategic plan.
Participant Selection

Primary participants were purposefully selected from a list of registered students who met the age, site, and prior experience criteria. I started at the top of the list I then called parents to explain the study and get verbal consent before getting signed consent. The study’s purpose was to better understand the insights, interpretations, and thoughts of preadolescent girls regarding STEM academics and careers. Participants were selected at a site that has preschool through eighth grade camp attendees. I chose female students going into fourth, fifth, and sixth grade because they were at the age in which they were beginning to form their science identities and were old enough to understand consent (Parr, 2010; Society for Adolescent Medicine, 2003). In addition, as has been discussed above, little if any research has been conducted that looks at the intersection of preadolescent girls, STEM, and persistence of interest over time. Two fourth, two fifth, and two sixth grade female students were selected for a total of six primary participants ranging in age from nine to eleven. The sample had a range of prior STEM experience; three of the six had previously attend STEM camp. Five of the six student-participants were Caucasian and one was Latina. None were participating in a special education program. The purpose of this study was to first focus on preadolescent girls’ perception of STEM content and careers. Consent was sought as students enrolled and met the aforementioned criteria. The parents were contacted via phone call to explain the purpose of the study and the extent of their child’s participation.

In addition to the primary participants, two additional secondary participant groups were selected. First, a camp director and three camp instructors were selected. All four were female. The director and instructors needed to have prior experience with directing or teaching in the SPS Summer STEM Camp. This criterion was to ensure they had sufficient experience and knowledge of camp operations and student experiences to fully answer interview questions.
Participation was voluntary. The instructor views are important to better understand how districts might support their professional growth and improve STEM instruction in the general education setting. The addition of instructor views also supports trustworthiness. The second group consisted of all fourth, fifth, and sixth grade camp participants at the same camp site as the primary participants. This group was surveyed and provided additional details to complement the qualitative primary participant interview and observational data. Approximately 40% of the registered campers were female. While the free and reduced lunch percentage could not be determined based on enrollment, the average approximation could be calculated based upon the schools from which the students came. Averaging the schools’ free and reduced lunch percentage resulted in a calculation of just over 60 percent. It may be higher given the Title 1 scholarships that were provided. This percentage is similar to the overall district percentage for free and reduced lunch participation. Enrollment by race was calculated based on overall district camp enrollment across four sites. Consistent with past camp enrollment, students of color were slightly overrepresented. This is partially due to a camp which is hosted at a site that only serves English Language Learners.

Data Collection

Data Sources and Data Collection Summary

This study relied upon multiple data sources and types. Six primary research participants were involved in this study. One camp director and three camp instructors were also selected as secondary participants along with all fourth, fifth, and sixth grade campers. Participants were interviewed and observed. The interviews and observations were transcribed via a professional transcription service. Camp demographic data was also collected and analyzed. Finally, a survey instrument was used with all fourth, fifth and sixth grade campers.
Before camp launched I met with the camp director to discuss the purpose of the study and my role at the camp. We toured the facility so I could become comfortable with layout and room assignments. I determined a suitable location to interview students as well as store my files. I used the staff break room in between observations and interviews to review my files and notes. On the morning of the first day of camp I was introduced to the camp staff by the director and I secured signatures from parent guardians for student participation. I spoke to parents previously by phone to get their verbal permission to interview and observe their children.

I had developed an interview schedule and began interviewing primary student-participants immediately. There were breakout spaces in each hallway which were semi-private yet visible and in close proximity to each participant’s camp session location. Two of the primary participants did not start camp until the second week. Three study participants participated in a two-week camp. I conducted their second interview on their last day of camp which was day four or eight, depending up on the length of their camp. I conducted observations on days two, three, six or seven, depending up on the length of the camp. This situated the observations in between the first and second interviews. Interview length varied from seven to sixteen minutes. Instructor and director interviews started at the end of week two and concluded at the end of week three. These interviews took place in a staff conference room adjacent to the school office. These interviews lasted from twenty-two to thirty-one minutes. All interviews were professionally transcribed and then coded. See below for details regarding data analysis.

Student-participant surveys were anonymous and given twice during the camp and once afterwards. Surveys were color-coded to ensure each administration was distinct and data was trustworthy. Surveys were placed into manila envelopes in class sets. I provided camp instructors with the class sets on Monday of each week and collected them later in the day. I provided the
class sets of the survey on the last day of each session to camp instructors as well. This was on the first or second Thursday depending upon the camp length. The third administration was done six to eight weeks after the conclusion of camp in September. A cover letter explaining the purpose of the survey was sent to each teacher along with copies of the survey appropriate to the number of students who attended the STEM camp. Packets included return envelopes. Surveys were again anonymous but as before, did ask students to identify their gender, grade level, and if they had attended camp previous to this past summer. All survey data was entered into Microsoft Excel as surveys were submitted.

*Interview Data*

Interviews are a critical form of data collection in a qualitative study. It was imperative that the participants’ views, experiences, and voice were authentically and prominently represented in the study. Seidman (2013) states that, “at the root of in-depth interviewing is an interest in understanding the lived experience of other people and the meaning they make of that experience” (p. 9). Interviews fall along a continuum of highly structured to unstructured and informal. At one end of the continuum are standardized surveys and are essentially the oral form of a written survey. On the other end of the spectrum are open-ended, conversational interviews with little or no pre-determined interview questions (Merriam & Tisdell, 2016). In the middle is a semi-structured interview in which the majority of the interview is guided by a list or pre-determined interview questions which can be asked in any order and used flexibly. This is the interview structure that was used in this study and recommended by Seidman (2013) for educational and social research.

Each of the six primary participants were interviewed in-person for approximately thirty minutes on the first day of STEM camp and again on the last day of their camp experience. For
example, if a participant registered for two weeks of camp, they were interviewed at the end of the second camp. All interviews were audio-recorded and transcribed for data analysis (Merriam & Tisdell, 2016). I used a semi-structured interview process and employed an interview guide with eight to eleven questions. Questions sought information about the student’s interest and self-efficacy in the STEM camp, STEM subjects and STEM careers which provided data for research question 1 (RQ1) (for interview protocol see appendix B). I used an unstructured or informal structure sparingly to gather some information, provide participant voice, and to build rapport both before and after the semi-structured interview portion of the meetings (Seidman, 2013). By following up with a second interview, I was able to compare both interviews and look for changes in interest and perception of STEM subjects and careers (RQ3).

The camp director and camp instructor interviews were also semi-structured and lasted approximately twenty-five to thirty minutes. The interview protocol (see appendix C) consisted of eight to ten questions and was conducted the final week of the 2018 SPS Summer STEM Camp. Questions focused on their observations of qualitative changes in female camp participants, if any, and the instructor’s own views regarding science and STEM (RQ2).

Field-testing of the student-participant protocol was conducted with two students from the researcher’s family prior to its use in collecting data for this study. Small word and phrase changes were made to enhance understanding. This was to ensure questions were clear and unambiguous to young students. All field-tested interviews were conducted in person. Interview transcripts of the adult participants were validated by the interviewees (Seidman, 2013). The secondary participants were offered the opportunity to read and correct any discrepancies or errors in the transcripts.
Observations and Demographic Data

In addition to interviews, observations are another primary data source in qualitative studies and are considered in the same category of fieldwork (Creswell, 2014). They are differentiated from interviews in that the setting takes place in the naturally occurring setting of the study affording the researcher first-hand insights into the phenomenon under consideration (Merriam & Tisdell, 2016). Observation locations were informally visited prior to formal observations. Systematic, descriptive observation was used to avoid what could be a highly subjective endeavor. Observations were used to help triangulate data gathered from interviews and survey data (Creswell, 2014). Consistent with an emergent design, interviews influenced to some extent the focus of the observations and likewise the observations influenced the interviews of the camp directors and teachers which occurred subsequent to the observations (Merriam & Tisdell, 2016). For example, additional follow up questions were used to elicit more data from participants. In addition, several clarifying questions were added to instructor interviews based on my observations.

One formal observation was conducted at the research site in each of the six primary participant’s camp classrooms helping inform all three research questions as both primary student and secondary instructor study participants were observed. The observation was approximately one hour. An informal observation in the form for several whole-camp walk throughs occurred prior to participant observations. As an insider-researcher access to the site was already granted. However, access was requested of the primary participants’ teachers to observe in their classrooms. Consent of primary participants was gained prior to the start of the STEM camp and in conjunction with the consent to interview. To support validation, observation narratives were reviewed by camp instructors.
The focus of observations can be influenced by the researcher’s knowledge of the literature, the working conceptual framework and research questions, as such “the focus must be allowed to emerge and in fact may change over the course of the study” (Merriam & Tisdell, 2016, p. 140). Therefore, I used an observation checklist as an informal guide to ensure specific elements were included in each observation. This checklist includes physical setting, participants, activates and interactions, and conversations. My role was as an observer-participant. This means that my role was known to the class and that any participation I had was secondary to the observation itself (Merriam & Tisdell, 2016).

Demographic data for all camp participants was collected. This collection was already part of the normal registration process and something that was collected and analyzed each year. This data will include SES as well as gender, race, prior camp attendance, and home school location.

Field notes formed the foundation of the data keeping for all observations. Field notes were typed and increased data acquisition. In addition, photos of the room and artifacts were also used and embedded into the field notes. In keeping with best practice, I wrote field notes into a full narrative format within 48 hours of the initial observation (Merriam & Tisdell, 2016). Consecutive line numbering was used to more easily reference significant passages within the observation narrative. Reflective or commentary notes were labeled so they are set apart from descriptive notes.

**Survey Data**

In this qualitative study all campers, whether primary or secondary participants, completed the same survey. Survey data can add value to a qualitative study by “extending the data collection process to a broader range of participants” (Stringer, 2014, p. 118). And,
quantitative data “can be productive for descriptive, exploratory, inductive, and opening up purposes” (Miles, Huberman, & Saldana, 2014, p. 42). In the analysis phase, and throughout the study, the qualitative and quantitative data were used to compare and contrast one another, providing broader and more well-rounded datasets from which to work.

The survey design was longitudinal, meaning the data was be collected over time. All Spokane Public Schools fourth and fifth grade camp participants at the research site took the survey three times. First, before camp began, second, just after the final camp session ended and third, six to eight weeks after final camp session ended. In this way, girls did not feel singled out. The survey was administered using a paper-pencil format to limit technical issues or access constraints. The first two administrations occurred in students’ camp classrooms. The third administration occurred in students’ fifth and sixth grade classrooms in September. The survey sheets were de-identified except for student gender and grade level. The registration database was used to determine age, race, gender, and prior STEM participation.

The survey instrument used was a proprietary instrument entitled the Upper Elementary (fourth and fifth grade) Student Attitudes toward STEM Survey (S-STEM) and contained four scales (see appendix D). The first three scales consisted of Likert-scale questions which asked the participants about their confidence and attitudes toward math, science, engineering and technology. In the next section, survey items asked students about their attitudes toward five different STEM career areas, their performance expectations for themselves in the next year, and whether or not they knew adults who work in STEM fields.

The survey instrument was developed at North Caroline State University at their Friday Institute for Education Innovation in 2012. The survey constructs were adapted partially from a survey used to measure female middle school students’ interest in engineering at Northeastern
University, Tufts University, Worcester Polytechnic Institute, and Boston University (Friday Institute for Educational Innovation, 2012). The instruments went through two rounds of revision after pilot administrations with thousands of participants. Using response data further testing was conducted and through factor analysis results indicated robust, clear constructs with high reliability after minor revisions (Friday Institute for Educational Innovation, 2012). The survey purpose is to measure student interest and self-efficacy in STEM subjects and careers.

Data Analysis

Analysis began as soon as the observations and interview process started. An inductive process was used and therefore conclusions and analysis deepened as the study progressed. For example, tentative codes were identified as the first interview transcripts were read. I wanted the process to be inductive. I wanted patterns to flow from the data rather than from my preconceptions (Creswell, 2014).

I conducted the first-round primary participant interviews on the first day of STEM camp. Observations occurred throughout the four-weeks of camp depending upon when each participant attended. Observations occurred in the latter half of participants’ camp experience. Since this occurred in a group setting it was less threatening, and thus less likely to be of influence. Following the group observation, I followed up with one additional interview of each primary participant on their final day of STEM camp. By this time, I was a familiar presence which I believe increased the participants’ comfort and willingness to elaborate during the final interview (Seidman, 2013). All interviews and observations took place within a four-week window starting the second week of July and ending in the last week of August.

I began the analysis process by listening to each of the interview recordings two times for each of the sixteen interviews I conducted. A constant-comparative method was to be used
(Merriam & Tisdell, 2016). Next, I began reading the transcripts which I had professionally transcribed. These were read as completed. This process allowed me to fully understand and become more familiar with all the content of the interviews.

After reading the first transcribed interview and listening to all sixteen interview transcripts twice I began to code the interview transcripts. Descriptive and In Vivo Coding were primarily used during the first and second rounds of coding. A total of 16 and 22 codes were found from the student and instructor transcripts respectively. Magnitude Coding was used and applied to these existing codes to indicate the frequency of occurrence. These were then combined into seven student and eight instructor categories. Finally, these were organized into three themes which form the outline of chapter four. During the second round of coding Emotional Coding was also used to account for participants’ emotions related to learning and teaching science, technology, engineering, and mathematics (Miles, Huberman, & Saldana, 2014).

I continued to add to the initial codes and categories as I reread each transcript a second and third time. Starting with the second reading and coding process I began to make connections across transcripts and noted the line numbers from each corresponding transcript. I also added more codes during the second and third reading. By the third reading I may have only added one or two codes total. This continued until I reached saturation (Miles et al., 2014).

Following the interview transcribing and coding process, I began coding the observation write-up. As I began reading through the observation narratives, as appropriate, I made connections to codes and themes from the interview transcripts. Observation narratives were read a minimum of three times until saturation was reached.
Concurrent to the interviews and observations, I began to review the STEM-EL survey results. Results were entered into Microsoft Excel and analyzed. I used descriptive statistics to compare results between each administration of the survey for all survey constructs (Creswell, 2014). In addition, results were compared with qualitative data. Miles, Huberman, and Saldana (2014) describe three ways to integrate quantitative and qualitative data. The first is to quantify qualitative data. The second is to make linkages between data types, such as interview responses and survey data. The third is the overall design of the study. I used the second to leverage the data interrelationships from the interview, observational, and survey data sources. The design of the study was also crafted to allow for the survey results and interview and observation data to influence one another through the use of a multi-wave survey, conducted in parallel with continued fieldwork (Miles et al., 2014). Responses were reviewed and analyzed for patterns and correlations to interview and observation codes and themes. These linkages are shared in the findings section of this study.

The final phase of the analysis process was to correlate codes across all the collected data. I looked for patterns and codes across and between the student and staff interview transcripts, observation write-ups, and survey data. These correlations were placed in a table and included tallies for frequency of occurrence and transcripts and operational write-ups were colored-coded to facilitate later reference and analysis. Next they were organized into more coherent categories and themes and a data visualization was developed to represent the themes and their correlations to each other. These themes and the display are discussed in chapters four and five.

In the final chapter, these themes and patterns are discussed using the lens of the study’s conceptual framework. I used Social Cognitive Career Theory (Lent et al., 1994, 2005) to discuss
the results from this study and elucidate the factors that impact students’ interest in STEM careers and coursework. I used the three models of SCCT (a) career interest and awareness, (b) academic and career choice making, and (c) performance and persistence (Lent et al., 1994) to discuss the results and their relationship to the literature. In addition, due to Culturally Relevant Teaching’s (CRT) foundational role, it was incorporated within the discussion of the three SCCT models.

**Ethics and Trustworthiness**

Confidentiality was explained prior to and when the participants signed the study consent form. Confidentiality procedures were also explained on the consent form. All notes and files were coded and pseudonyms were used for the research site and each participant. Parental permission was gained for all minor participants (see participant section above for more detailed information). The research source files were not shared outside an academic setting with the exception of granting access to a professional transcriber. The transcriber agreed to confidentiality prior to employment. Notes and associated files were maintained on a password-protected computer or in a locked file cabinet unless on the researcher’s person. Identifiable information was not shared with other district personnel. This was explained to the research participants, their guardians, and the camp director in advance of the study commencing.

Participation was strictly voluntary and without any remuneration. There was minimal risk to research participants due to the nature of the study and the confidentiality safeguards discussed above. To support trustworthiness, I used multiple sources, and ten interview participants to triangulate the data. Three types of data sources were used including interview transcripts, observations, and survey data. Finally, extensive engagement with the data took place to reach saturation.
Working with Young Children

In all studies, researchers must take great care in protecting participants from harm and further, and strive to be of benefit for them (Creswell, 2014). This is even more true for qualitative studies because, as Orb, Eisenhauer, and Wynaden (2001) state, “qualitative researchers focus their research on exploring, examining, and describing people and their natural environments. Embedded in qualitative research are the concepts of relationships and power between researchers and participants” (p. 93). Regardless of age, researchers must adhere to The Belmont Report’s (1978), three basic ethical principles of beneficence, respect for human persons (autonomy), and justice. Orb et al. (2001) explain the principles further:

- beneficence—doing good for others and preventing harm;
- autonomy—including the right to be informed about the study, the right to freely decide whether to participate in a study, and the right to withdraw at any time without penalty; and the principle of justice refers to equal share and fairness (p. 95).

In addition to these principles, when working with vulnerable populations, additional safeguards must be put into place. Vulnerable populations include minors, prisoners, decisionally-impaired individuals, students or college employees, institutionalized individuals, economically or educationally disadvantaged individuals, non- or limited English-speaking people, and HIV-positive individuals, among others. The US National Library of Medicine National Institutes of Health (Preethi, 2013) put it this way, “vulnerable individuals’ freedom and capability to protect one-self from intended or inherent risks is variably abbreviated, from decreased freewill to inability to make informed choices” (p. 53). Upper elementary aged students fall into this category on at least two levels: age and their status as students.
In addition to standard precautions of confidentiality, assent of the minor, and consent of the guardian, it was critical to implement additional ethical safeguards. Minors should not participate in studies with greater than minimal risk unless there is direct benefit to the child. Minimal risk is defined as, “the probability and magnitude of harm or discomfort anticipated are not greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests” and include educational interviews (Belmont Report, 1978). However, despite risks several agencies and governmental bodies including the NIH and the FDA have urged researchers to include minors in research due to the potential benefits (Society for Adolescent Medicine, 2003). The report’s authors go on to state, “research on cognition and capacity suggests that both adolescents and younger children show significant ability to provide informed consent” (Society for Adolescent Medicine, 2003, p. 399). However, it is important that researchers adhere to best practice with regard to informed consent and vulnerable populations including children.

Consent with young children is complex and multifaceted. Researchers must consider the ability of the child to understand consent as well as the power imbalance often associated with the researcher and research participant (Gallagher, Haywood, Jones, & Milne, 2010). Researchers must acknowledge these complexities in their research and use reflexivity as a tool and discuss the limitations within the study itself (Gallagher et al., 2010; Phelan & Kinsella, 2013). Going further, including students as research-participants empowers them and provides voice and ownership and increases students’ opportunity to mutually benefit (Parr, 2010). New approaches such as using narrative story and images to help young children understand the nature of their participation can be used to further support equitable involvement of even very young children. (Mayne, Howitt, & Rennie, 2016)
In the case of this study, the focus was on interests and confidence in school related STEM subjects and did not delve into the familial arena. The study was situated at a voluntary educational camp where students regularly were asked to solve problems, answer questions, and write to prompts. The addition of a survey or questionnaire was not out of place in that environment. Both primary and secondary participants had the opportunity to benefit. Since I was an insider-researcher, I had the ability to apply insights gained from the study to make program improvements to both STEM camps and STEM programs during the school day. These improvements occurred during the same school year. In addition, research has shown that simply being part of a research study has experiential and cognitive benefits for adolescents (Society for Adolescent Medicine, 2003, p. 399).
CHAPTER FOUR: FINDINGS

Study findings were obtained from three primary sources. These include interviews of students and staff, survey data from camp participants both before and after the camp experience, and observations of students during camp. The findings will be shared by theme which emerged from the coding process rather than by research question or by the data sources listed above.

Study findings pointed to several factors which appear to influence student interests in STEM subjects and careers. Three themes emerged from the data. They speak to the student experience and perception of STEM camp. They relate to How (constructivism and agency) the camp content was organized and presented, What (STEM content and careers) content was included and how students responded, and finally how the experiences at camp related to Who (identity and interests) the students and staff saw themselves to be. Similarly, instructor themes emerged in the areas of constructivist teaching and learning. Instructors also spoke to the value of STEM content and careers but instead focused on the importance exposure and role models. Finally, similar to students, instructors discussed identity and feeling welcome, however, instructors also shared their own experience as a camp instructor and how that impacted both their views of STEM subjects and teaching STEM. Consistent with a parallel-mixed methods design, discussed above, data from all sources will be integrated by theme. Each theme will begin with student interview data followed by survey and observational data, when relevant. At the conclusion of each theme instructor interview data will be shared. First, a description of the camp experience will be outlined followed by a short overview of the survey data will be shared to provide context for the themes that emerged in the qualitative data.
Camp Experience

To review the setting from previous chapter, the study took place at a preschool through eighth-grade summer STEM camp. Students attended camp at district a middle school serving a semi-urban community. Dozens of sessions were offered over four days. A complete list of camp session offered are listed in the camp brochure (Appendix E). Camps ran from 8:00 a.m. to 1:00 p.m. daily and were repeated and offered over a four-week period. Students began their day greeted by camp counselors who directed students to a large cafeteria were breakfast was offered. Most students took advantage of the free meal. Students ate with their fellow camp participants and their camp instructors creating a family like atmosphere. Some parents stayed for a short time or checked in with camp instructors. As the week went on most parents dropped students off at the curb and did not come inside the school. After breakfast students were led to their camp location by their camp instructors who held signs high with students’ camp name listed.

Sessions took place throughout the building and were chosen based upon the camp’s needs. For example, a video editing camp was hosted in a first-floor computer lab. Most camps were clustered by one-another to support supervision and efficiency, such as delivery of supplies. Several sessions were held together in the library. This supported camp instructor breaks and met the needs of the camps, such as the drone camp which needed high ceilings.

Some students repeated sessions or attended different sessions over the four-week period. Each session included the following curricular resources: A PowerPoint with goals, tasks, vocabulary, and career connections. Some camps included a science notebook which had graphic organizers to support knowledge acquisition through non-linguistic representation of text. Each day started with a mini-lesson and review of previous content. Next, students began working on
their projects or tasks individually, pairs, or small groups depending up on the session goals or the task for that day. Instructors would periodically pull the whole group together to address misconceptions or to teach additional concepts, facts, or skills. In between these mini-lessons instructors helped individual students as needed. Typically, sessions ended with a review of the day’s work and a preview of what to expect for the following day. Scheduled breaks and lunch were also interspersed throughout the session each day. Lunch occurred in the cafeteria where students again sat according to their camp along with their instructors. Breaks took place outside on the ball fields and included common equipment such as basketballs and frisbees.

The STEM sessions fell into the three broad STEM content categories: computer science, biomedical science, and engineering. The summer STEM camp has been offered for five years. Periodically, a student may switch camps mid-week based on fit and student, staff, and parent feedback and consultation. Proportionally, camps typically started with more direct instruction in general and moved towards more project-based independent and small group work as the week progressed. Students had a lot of autonomy and in some cases were allowed to work on special, independent projects. Students consistently collaborated with one another on projects and tasks. Communication amongst campers was a common feature throughout the camps. Some camps culminated with final projects which students took home (i.e. kids love construction, produced video, etc.) while others concluded with a challenge (i.e. drone obstacle course). Next a brief overview of the survey findings will be discussed.

**EL-STEM Survey Findings**

The STEM survey was organized into two constructs, STEM subjects and STEM careers. The STEM subjects included in the survey were math, science, and engineering and technology. The STEM careers included were medicine, engineering, computer science, earth science, and
mathematics. As discussed above, all students were surveyed so that female students did not feel singled out. While the focus on this study is solely on female students some data is shared from male students to provide context and serve as a comparison.

**STEM Subjects**

In general, the engineering and technology category had the highest initial ratings followed by science and then mathematics. This was true for both males and females. Overall, female scores on the pre-camp administration of the survey were lower than males. Males had higher results in 14 of 19 survey questions. Growth in interest occurred for both genders, including those returning and new to camp. However, the most significant growth occurred for girls new to camp. Growth in math was 5% and growth for science and engineering and technology was 10% when rounded to the nearest percentage point. For math and science, the respective growth was six times higher than girls who had attended camp previously. Growth was ten times higher for engineering and technology, when comparing first time female camp participants to returning students.

Table 2

*Student-Participants’ Interest Growth in STEM Subjects from Pre- to Post-Survey*

<table>
<thead>
<tr>
<th></th>
<th>Returning to Camp</th>
<th>New to Camp</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM Subject Interest: Math</td>
<td>1.0%</td>
<td>4.8%</td>
<td>2.4%</td>
</tr>
<tr>
<td>STEM Subject Interest: Science</td>
<td>1.5%</td>
<td>9.7%</td>
<td>6.0%</td>
</tr>
<tr>
<td>STEM Subject Interest: Technology and Engineering</td>
<td>0.0%</td>
<td>10.3%</td>
<td>3.8%</td>
</tr>
</tbody>
</table>

Overall, females returning to camp started with higher interest in these STEM subjects but had less growth than female participants new to STEM camp. This indicates an overall trend
towards narrowing gaps in interest based on prior experience. The same trends were not as clear for male participants. For example, while males new to camp had slightly higher growth percentages than returning males for math and science, this was not the case for the engineering and technology category.

**STEM Careers**

Within this construct the five careers were rated on a scale of one to four. One being not at all interested and four being very interested. Average scores for both male and female participants ranged from two to three. Girls were most interested in engineering, computer science, and Earth science at the outset of camp. This was the same for males. Female camp participants showed the most growth regarding interest in STEM careers, 10.3%, when comparing the first and third administrations. Growth for males overall was 6.8%. Similar to results for STEM subjects, female participants new to camp had the largest increases, 12.3%, when compared with returning female participants, 8%.

Results for individual career interest was uneven for all groups. For female campers returning to camp, Earth science, medicine, and engineering showed the most growth. For new female participants, engineering, computer science, showed twice the growth of medicine and Earth science. This may be due to their lack of prior experience with engineering and computer science in school. While male participants showed overall higher interest in STEM careers at the outset of camp, due to higher growth over the course of STEM camp, female campers indicated slightly higher interest in STEM careers on the third and final administration of the STEM survey six to eight weeks after the conclusion of camp. With this summary of survey results in mind, below are data from all data sources, including the survey, organized by each of the three emergent themes discussed above.
How: Constructivism and Agency

One theme that quickly emerged from student and staff interview data centered on the nature of how learning was positioned throughout the camp. Rather than being passive, camp participants were actively engaged in learning new skills and content. The three categories within this theme were constructivism, agency, and learning as fun. Students and staff spoke to their affinity and ability to construct, build, and create during STEM camp. This seemed to be a defining feature of the camp experience and served as a differentiator when compared with the traditional school experience. A second category was agency. Student and staff spoke of choice and inquiry. The ability to pursue and direct their own learning. This section will start with interview data from students followed by relevant data from observations and the survey. Finally, interview data from staff will be shared.

Constructivism

Students seemed to prefer being active rather than passive. Almost every participant initially spoke of liking or wanting to build something. They spoke of things like, “I like to build and fix things.” And “I like building with Legos and I want to make a tree house.” During later interviews, when talking about active learning at camp students talked about building, creating, and experimenting. “We get to do stuff and test things, like see what happens if we mix things together or see how water rising effects land.” And “We interact with science.” When asked how STEM camp was different from how they learn science or technology at school Ava said, “Because at STEM Camp, you actually get to be involved and actually do it. Usually at school,
you get to draw sticks for partners but here you usually get to choose partners.” Another participant, Emma¹, also compared camp to her school experience:

It doesn’t feel like school. It’s just like summer camp is more active, and like school you just pretty much sit all day and the only time you really get to play is at recess. I don’t really like just sitting all day, I like doing stuff.

Students indicated that it is the experiences that attract them to camp. When asked why they come to camp students talked about how it was fun and about their experiences. One participant, Janessa, in her first interview said it this way, “Because it’s fun to learn about all of these science and math experiences. Because it’s pretty fun, entertaining, it gives me something to wake up for” (emphasis mine). She went on to say about camp, “It’s a lot more fun, yeah, you’re not allowed to have fun while learning (at school).”

Participants also discussed how a constructivist learning environment at camp contributed to their learning. During her second interview, Janessa illustrated it this way:

So how we learn, we get to feel things. So, it’s kind of like it’s better. Well, it’s easier to get through your brain. Let’s say we were learning about shapes. Let’s say I was in first grade or something. Feeling something while talking about, it helps, because you can see it visually, you can feel it.

Similarly, another participant, Sophia talked about how the science process is more important than the end product. She said it this way, “What’s super important about science would have to be that you get to learn from your mistakes. And science always is fun, so you don’t really need to worry about it, it’s just fun.”

¹ Pseudonyms are used for all participants in this study
Students also spoke to the difference between passively using technology and using technology to create or build. They seem to prefer tangible, hands-on engineering experiences. Emma reflected upon an experience designing a roller coaster on a computer. “It was really cool, I liked that. That’s pretty much the only thing. I don’t really like designing other things on the computer. I’d rather do hands-on, being able to touch something.” When asked about using technology to create versus consume (e.g. watch a video) another participant, Hayden, stated:

It’s hard to explain really. It’s just like, kids kind of get used [to] being on electronics and stuff, and it’s kind of different from just being on your tablet or computer because you’re actually learning at the same time at camp.

Students, like Cecelia, did talk about enjoying being able to design objects or control physical objects through coding or technology during their second interview, “It is cool seeing it visual and making your own. It is really exciting because it’s like, I made this, I can’t believe I made this.” Another student, Ellie, shared her experience:

I love to see [what happens] when I do code. I can do very many things with code. I could make a drone fly, or maybe someday people won’t have to drive cars. They could just program the car to do something, or a plane.

Interestingly, the single highest rated question on the STEM survey by female students was, “I like to imagine creating new things (toys, tools, or products).” Eighty-three percent of female participants said they agreed or strongly agreed with this statement. In general, the engineering and technology section of the survey had the highest scores when compared with math, and science alone. Responses were approximately 15% and 10 % higher, respectively. While the STEM acronym stands for science, technology, engineering, and math, the focus of camp in on engineering, computer science, and biomedical learning. While these include math
and science, these content areas are not the focus of camp. This may contribute to the disparity of numbers above.

**Agency**

In addition to constructivist learning, where students actively build their understanding through hands on activities and experiments, students and staff discussed the importance of choice and inquiry—the ability to pursue their own questions and wonderings. Sophia stated, “I just want to explore,” one fourth grade student said. When asked about the difference between camp and regular schools, students talked about having more control and choice. In her second interview, Sophia expanded, “Instead of just being [given] certain instructions, they let you do your own thing.” At the end of her camp experience Anastasia was asked about her favorite experience at camp and she discussed creating a video in a small group that had full control of the topic and process.

It was amazing. We all had ideas and then together we came up with a horror movie. It took us multiple tries to get the video correct. Even though it was only five minutes, it took us the whole two weeks. But that’s because we were working upstairs. No one else was actually upstairs so we were able to control lighting and everything. But we were having so much trouble with it, but we were having fun, so it didn’t feel like it was much trouble.

Students also talked about the ability to choose the camps themselves, not just what projects to work on while at camp such as when Ava shared, “Also, we get to choose different camps”. Another participant, Hayden said when asked how she would describe the camp to a friend, “So, STEM Camp is this thing where you can join into different groups or camps. And
you can either choose *Make My Game*, which is the one I did. There’s a bunch of other cool ones.”

The observations conducted during STEM Camp helped corroborate the data outlined above. Each camp had several features which encouraged students to build and create projects and ideas upon prior learning and knowledge. This was true for both online and offline STEM Camps. For example, during the *Kids Love Construction* camp, students were encouraged to develop and build a project of their choosing. Prior to the design and building process, students learned basic construction vocabulary and concepts and built a small project. Even during this phase, students could customize their project. This exemplifies both the constructivist and agency nature of the STEM camp activities observed.

During *Kids Love Drones* students had the opportunity to build their own command sequences for their drones in pairs. Eventually, students were tasked with an obstacle course challenge. Even during this challenge, students were encouraged to write unique code to maneuver their drone throughout the course, rather than replicate a set of commands provided by the instructor. Students were seen busily writing and testing their codes, making revisions, and discussing strategy with their fellow campers.

In addition, students typically were given the option to make choices regarding the nature of their task or, in some cases, the task itself. This was true for both advanced students and students new to STEM camp. For example, during the advanced *Arduino Camp*, students developed games and applications of their choosing. They were even allowed to explore code that was not originally part of the program, which showed flexibility on the part of instructors to customize the camp experience based on the students in their sessions. Similarly, in *Make My Game*, novice students too were allowed to be creative and develop custom games based on their
interests and backgrounds. This agency seemed to increase student engagement and ensure that all students, both novice and experienced, were challenged.

One student with special needs, and exceptional talent and experience, was allowed to work on an independent project throughout the camp. None of the established camps would have met his needs. Instead, a custom camp was developed in which he received individual coaching from camp instructors between teaching their own camps. In talking with camp instructors, this is not an uncommon accommodation.

Inquiry notebooks and engineering notebooks were also employed throughout the camps. Students used these notebooks to record their ideas, thoughts, tentative plans, and notes to remember later. They were used as tools for students to record their own ideas, rather than containing information students should memorize. During observations, these notebooks were observed being used about half the time.

Unfortunately, there was a camp where learning was not as engaging or well planned. In the Girls Love Legos camp, some students were simply playing with LEGOS and not building simple machines or learning about the engineering process. Later during one of the staff interviews I learned that they had not received the instructor manual. Later in the week they made some adjustments, intentionally discussing what STEM meant with the campers and why it was important for them to be there, but the instructors shared that there were some missed opportunities.

Learning is Fun

Another category within this theme that emerged from the interviews centered around the idea that learning could or should be fun. There seemed to be an expectation that learning STEM content is fun and that the STEM camp in general was more enjoyable than the instruction they
expect to receive during the school year. In this section data will be shared from student interviews and camp observations.

Camp student participants often talked about how camp or camp activities were fun during their second interviews. These comments were at times tied to the categories of constructivism and agency discussed above. For example, after just one day at camp Sophia shared, “It’s actually really fun and interactive. We did a bunch of cool stuff. You could actually get in there and do stuff and do experiments and things.” Ava, when asked to share about an experience at camp said, “The obstacle course that we’re doing. It sounds like a fun challenge.” When asked how this was different than school she said, “Because STEM Camp, you actually get to be involved and actually do it.” Janessa summed up what several other students shared, “It’s a good way to learn and have fun at the same time.”

Participants also discussed being challenged and yet having fun in the process as exemplified here by Anastasia in her second interview:

It’s fun, but it is also work. It feels like you’re not working, but it is work and when you do hit a challenge, you will hit that wall, but it won’t be as hard as it normally is in school to get past that wall.

Students were quick to point out that while camp was fun they were still learning. For example, Cecilia shared on her first day, “It is really fun and it’s not just like having fun, it’s also education and learning in the summer. So, it’s like, you get to do fun things while learning.”

During observations it was noted that other camp sessions had similar exchanges in which students were laughing and at the same time very focused, often not wanting to take recess break or leave at the end of the day. On multiple occasions I observed staff allow students to remain in the library during breaks so students could continue to work on their projects. For
example, a student asked to stay back and work on her drone code for the obstacle course, to “get it just right.” Another example was during the Camp Crime Scene. The students were on the verge of figuring out a key mystery based on some newly understood clues but the clock struck 1 o’clock. The students asked if they could please keep working for a few minutes but due to bussing the instructor had to end the session, with a smile. Next, data related to the theme of constructivism and agency which was gleaned from instructor interviews will be shared.

**Instructor Views of Constructivism and Agency**

Similar to the student participants, instructors also discussed an environment at camp which was constructivist in nature and how it was similar or different from the typical learning environment during the school year. All instructors had familiarity with typical school instruction and, Garcia and the camp director had elementary teaching experience in public schools.

Discussing a two-week camp, Garcia’s comments illustrated this point:

> We had a two-week camp. You could see the difference between week one and week two. And it’s really interesting, especially in Camp Crime Scene, because you spend the first week learning. So, the first half of the day is kind of a more school atmosphere. Where you have to sit and kind of get some of the information, before you can put it into practice. And so, the (students) were like, man, we have to sit here and take notes? This illustrated campers’ dissatisfaction with a more traditional learning approach while at camp.

Students reaction to week two will be shared at the end of this section. The camp director also saw the camp as more participatory and related it to her experience in a Montessori program.

> “So, [camp] is almost a little bit more like Montessori here, in where we do kinda leading questions. Like, ‘what do you think that’s going to look like? What do you think that’s going to taste like?’ More project-based.”
The camp staff, such as Kirsten, also highlighted student inquiry, choice and agency during their interviews. “There’s a ton of different options for camps so (campers) can just do whatever [they] want and then put that to use in school or wherever else they want to.” The camp director shared that they are “just trying to get them to think and come up with some answers instead of kinda handing it to them. It’s really just trying to get them to think outside of the box.”

When asked how STEM camp is different than school, instructors, here Garcia, talked about agency and having the time to focus on an area of interest.

It's a lot more hands-on, and it's a lot more, you get to choose what you want. So, you can choose, I really love chemistry, let me go take an extra week of chemistry. Or I really love engineering, let me go build something, or I want to learn how to fly a drone, or how to code.

Another instructor stated it this way:

There's just so many more chances to go a little bit deeper, and get a little bit more hands-on, when you're at camp. Because you have five full hours that you can just completely immerse yourself in the science, in the math, whatever it is. And you don't have to divide your time between anything else, because you're just there for that. And that's all you really need to care about, for the entire week.

Another instructor spoke to the importance of the process over product and how STEM camp supports this inquiry-based thinking. Education used to be:

Okay, this is the right answer, this is your process, this is the way you do it. You find your process, you find how to get to that end product; and if you get there, that’s great, but we’re looking at what’s happening in that process, not what necessarily happens at the
end. Let’s go back through and reflect on your process, ‘How did you get there? Why did you use that?’ And not, ‘Did you get the right answer? Let’s move on’.

When that same instructor was asked if teaching at STEM camp has changed how she teaches she said she now uses a more “open inquiry process.”

Instructors also spoke to the category of Learning as Fun during their interviews. The camp director said it this way, “I see the kids having fun and they’re just really enjoying what they’re doing. I hope that sparks a passion in them for something.” Even the instructors found camp to be enjoyable. When asked why they keep coming back each year instructors talked about the value of working with students, continuing summer learning, and that it was fun and rewarding. “Because it’s so much fun. There are things that I never would have let myself experience, unless it was at STEM Camp. It is so cool to watch kids just light up.” She went on to share a story about student’s in week two of Camp Crime Scene, after having completed the more traditional lessons in week one, getting excited about what they were learning:

Then we get to the labs. They got to do it, the fingerprinting, and the girls were so excited to lift latent prints. We kind of challenged them and had them do their first latent print on a surface that wouldn’t lift latent prints, to make them figure out why it didn’t work on that surface. They were so frustrated, they were like, ‘Why isn’t this working?’. I was like, ‘Why is it not working?’ and one girl rushed back to her table and got out her notes, [she said] It’s because it’s not the right surface.’ And then we had to leave because the day was over. And they all left that day, trying to figure out where can we go now. ‘If it didn’t work there, where else are we going to go?’
The students were so excited they didn’t want to leave. They asked to keep trying different techniques. The instructor had to say, “No, we gotta go now guys. I’m like, no, no, let’s go” [laugh].

In this section, data were discussed related to how camp activities and instruction took place and how students responded, based on patterns in students’ perception as well as how staff responded. Data related to a constructivist teaching and learning style were shared. In addition, data related to student agency were displayed. Finally, student and staff’s perception that learning was simultaneously fun and often challenging was also shared. Students spoke to both wanting to be in control of their learning and working in a learning environment that was active and hands-on. Instructors also commented on these categories further corroborating this theme. Both discussed their preference for a constructivist learning environment compared to a more traditional sit and get, passive, learning style. Students came to camp knowing they liked the more active nature of learning. Over the course of the camp students were better able to articulate why and how these learning environments supported their learning. Next, data about content and careers from interviews, observations, and surveys are organized into three categories in a theme called What: Value of Content and Careers.

**What: Value of Content and Careers**

Another theme which was prominent in the data focused on the value students and staff placed upon the subjects of math and science. Two categories emerged in this theme. First, the value of science, technology, engineering, and math content. Students and staff seemed to agree that these disciplines were important for all to learn, even if they themselves did not have an affinity for them. Additionally, a sub-category of seeing technology as a tool for learning surfaced. They saw technology as a tool to help further their learning and pursue their interest
rather than a pursuit it in its own right. In the second category, students saw value in STEM careers as evidenced by their interviews and survey data, but their expectation to use and pursue some STEM pathways was mixed. As before, student data will be shared first followed by data from camp instructors.

**Value of STEM Content**

Staff and students were clear about the importance of STEM content. This came through in both the interview and survey data. Students seemed to value content and careers even when they themselves did not enjoy or plan to pursue them. During interviews students were asked what feelings or emotions came to mind when they heard the word science or math. They were asked if it is important to study STEM subjects and if their future pursuits will be STEM related.

Students were quick to share that they were “excited,” that it was “fun,” and that they had “happy” feelings related to learning science and math. Hayden said, “I like science, so it actually makes me happy.” Anastasia said, “I feel excitement that I get to do something that makes something else explode. I love science!” and Emma said, “It’s fun, important. Science is all around you.” Sophia said, “Engineering is kinda really fun for me because we learned how to put stuff together.”

Students seemed to see the relevance of science to their lives. When asked why it is important for students to learn about science, Ellie said, “I would say that it tells you a lot about the Earth and how things work. When you know how things work then you would know more about how everything is working, and that’s pretty cool to me.” Ava said, “Science is mostly in everything, we need it for lots of things.” Anastasia related the importance of science to what is being discussed in popular media. She said it this way:
In our day and age, science is becoming bigger than most people think. They think that technology is growing. But we need the science to get the technology going. And also, if the way that our Earth is going with overpopulation, and we are slowly killing the Earth faster than we thought we would. But we need science, so we can figure out if we can live on other planets or if we can get out of this galaxy and into another galaxy. Where there would be more, where there could be more planets like earth and how we can survive in space. Because that will take multiple light years.

In a similar vein, Janessa shared:

It’s important so we can learn about how things work, like you just stare at the sky, how is that sun appearing every day? Like the cavemen didn’t know that, but today, scientists learned about it and now teachers teach us.

And, Ava shared about the importance of learning science to our health:

It’s important to learn about science because science is like, you know how doctors, they use science to help you. Without science there would be no doctors and that means if you have an disease for example, you have a very bad sickness like cancer and there are no doctors to help you, then most of us would be dead. That’s why science is very important.

Similarly, students, such as Ellie here, commented on the value of math, engineering, and technology. “I like math a lot. It is important to learn about math because it’s used in so many jobs. And you can learn many things with math.” Another said because “it’s in a bunch of stuff. You need it for a lot of things.” And still another, “math is all around you.” However, only four out of the six students discussed math’s value explicitly whereas all participants did so for science. Furthermore, as you can see above from the responses, student comments regarding
math and its usefulness were more generic and one-dimensional when compared with how students explained the usefulness of science.

In addition, not all participants had confidence or enjoyed math as a field of study. They seem to understand the value of math, but not enjoy learning it as a content area or be as confident to master it. “I do not like math at all, to be honest. I just don’t really feel that good (at it).” Or “I’ve never been good at math.” But, Sophia added, “you can get smarter” with math. Another participant, Emma said, “Math isn’t as fun as science to me. I can do it and once I get the hang of it, I’m really happy, but not as happy as when I get the hang of something in science.” Others saw how math and science are interrelated. When asked about the importance of math they would explain math is needed to understand science and technology, For example, Janessa stated, “Yes, it is because math leads to science and science leads to math, so you need both to do whatever you need to do.” These statements occurred in both the first and second interviews. Student views did not seem to change qualitatively regarding how they felt about science or math content. During observations it was clear that most camps did not include explicit math content as a focus and only a few taught specific science content, such as Camp Crime Scene. Instruction focused more on the scientific process, engineering, and technology.

The survey data add additional information regarding students’ thoughts and feelings related to STEM content. As discussed in chapter 3, the S-STEM survey contains four categories (see appendix D). The first three categories consist of Likert-scale questions which ask the participants about their confidence and attitudes toward math, science, and engineering and technology. The survey was administered before, directly after and six weeks after the STEM camp experience. The survey was anonymous, but students were asked to identify their gender and if this was their first-time attending STEM camp, therefore, no data will be disaggregated by
any other demographic data. Over 150 students participated in the survey in grades four, five, and six.

Students’ attitudes towards these three content areas seemed to match students’ interview responses. Math was rated the lowest with 59% of female students agreeing or strongly indicating having a positive attitude. For science was in the middle 65% indicating a positive attitude. Engineering and technology had the highest positive response rate with 69%. When considering findings of the male students, science and engineering were nearly the same at 66% and 69% respectively. Math data was higher at 63%.

In terms of changes in attitudes towards math, science, and technology and engineering, math showed the most resistance to change with only a 2% improvement from the pre and post assessment. However, female students attending STEM camp for the first-time saw a gain of nearly 6% points. Slightly more modest gains of 4% were seen for first-time male students. These students maintained these gains six weeks after the camp when the same students were given the survey for the third and final administration. The two questions comprising the sub-category of confidence in subject were the highest at 69% and 72%. Half of female students felt that math was their worst subject and this changed only a nominal amount, 2% in the positive direction.

Again, similar to the qualitative data, student attitudes towards science were higher overall when compared with mathematics. However, student attitudes did not increase over the course of the camp on two of the six questions in this category. For example, on question nine, “I expect to use science when I get out of school,” students’ responses remained flat. However, on a similar question, “I will need science for my future work or job,” student responses increased by 13 percentage points. Another question asked students if science will help them earn money in
the future. Student responses increased by 8% and six weeks later increased further to 10%.
Overall, female students new to STEM camp showed improved attitudes towards science in all categories when compared to the pre-camp survey and the six-week post survey eliminating the gap between males and females to 1%. This same growth was not seen for new male students, however female students came into camp with a lower initial positive attitude towards science, 64% versus 67%.

Student attitude towards engineering and technology was the highest of all three constructs. In addition, several of the highest question responses were from this construct. Well over two thirds of female students responded that they agree or strongly agree with the following statements: I like to imagine creating new things, If I learn engineering, then I can improve things that people use every day, I am good at building and fixing things, I am interested in what makes machines work, and I am curious about how electronics/technology work. While students who attended previously had higher average ratings on the pre-camp survey, 72% versus 68%, students who attended camp for the first time had the most growth at 10% when compared the pre and six-week post survey averages for this construct. Overall, male students had higher positive attitudes towards engineering and technology when compared with female students. Similarly, students new to camp had higher gains, 12% compared with 6%.

In summary, students and staff discussed the importance of STEM content in the areas of math, science, engineering and technology during interviews during camp. This was true even when students indicated they did not enjoy math lessons or instruction during the school year. The survey data was a bit more mixed with regards to math and science. Again, it is important to note that camp sessions focused more on engineering, computer science, and technology than
math and science content. Students attending camp for the first time showed the most growth in positive attitudes in all three constructs. This was especially true for female students.

**Technology as a Tool to Learn**

A sub-category to the category of the Value of STEM content emerged from the student interview data. This sub-category was seeing technology as a Tool to Learn. Students spoke about leveraging technology to learn other content, often independently. This is separate from an interest in technology or the other contents in STEM. Below are excerpts which illustrate this finding within the theme of valuing STEM content. Students talked often talked about using technology as a reference source. They said they often use technology to, “Look stuff up,” or that “It helps us learn,” and that “You can learn from a computer.” Also discussed was that technology can be used as a tool to do other things, such as shared Anastasia here, “Some of my video camps will help me if I need to make a documentary. They’ll get me ahead.”

Hayden spoke of technology as a friend that can help her:

I actually love just seeing the lit-up screen just welcome me to the electronic world. And there’s a bunch of stuff that I can just figure out on a phone or a computer (that) can help me with a bunch of stuff.

Similarly, Janessa shared:

Technology, I like to learn things on the computer, on YouTube. I look up things, and there's games on it that actually helps you learn more things. And there are games that help you develop more sense, too, that help you so you can be smarter and grow a healthier brain.

In this section, student data related to the theme of the value of STEM content and careers was shared, the What. It was organized into the three categories of the value of STEM
content, careers, and technology as a tool for learning. In the next section I present data related to STEM careers.

**Value of STEM Careers**

Both staff and students spoke about their interest in, and the value of, STEM careers. The S-STEM survey also asked students about STEM careers in the fourth construct. This section will begin with students’ responses to interview questions related to STEM careers. Next observations related to this topic will be shared followed by survey response data from students. Finally, at the conclusion of this section staff data from interviews will be outlined.

Many of the participants spoke about their interest in STEM careers. Several knew right away, “I want to be an engineer, making houses. Next week I’ll be doing engineering [camp].” Others were fairly tentative which is appropriate for this age, for example, “I forgot what it is called, where you study space. I am just going to say scientist,” Astronomy? “Yeah! Going to places that we’ve never seen before. Trying to get to another galaxy”.

For some, it was related to careers they have heard about or that their parents held. For example, Sophia shared, “What I really want to do when I grow up, I actually really want to be an electrician, like my dad. It might involve engineering and science.” During her follow up interview when asked if she would need STEM content knowledge and experience to reach her future goals she said, “Actually, I think it will involve all of those things because as an electrician, you’re going to need a bunch of experience. You’re going to need to learn a bunch more.” Others talked about an interest in careers and the benefit of STEM content even if they have another career in mind. For example, when Ava was asked about engineering, she said:

I actually kind of think it’s a little bit fun because I’m one of those people that like to build, that like puzzles. I am very interested in building stuff. So, when I grow up, even if
I really don’t want to be an engineer, because I want to be a vet. For example, if one of the pets needs surgery, it is basically engineering.

Ellie’s reflection shows her self-perception of her abilities is still being worked out. She shared:

I want to be an author and a literature professor. I like [science and engineering], but I don’t think that is a job that I could do as well as I would like to. I really do like it, and I think I’m fairly good at it, but would rather do writing because I feel like it is very, very creative to me and I can almost do anything with it.

Still another participant, Cecilia had several interests, “Maybe astronomy or an architect or a chemist or a support scientist or a doctor.” Later, in her second interview, when asked what goals she had the Cecilia was surer of herself and more specific. She stated:

I want to be an architect. They use science because some of them have to make the parts to build and stuff. You can use different types of science to make a certain thing, and then, well, it just all comes together.

While not every student had a goal of pursuing a STEM career most did discuss STEM careers or the use of STEM content in their chosen career during their interview. Janessa shared:

I want to be a farmer because I love animals and I can live off the stuff and I can make money out of the stuff they make for me. So, if I get chickens, goats and cows I can have cow milk and I can have goat milk and I can have eggs at breakfast. I could use science to predict how many eggs I will get in a couple years, or how big, how much milk the cow (produces); and how much do the eggs cost and stuff like that.

Data from the S-STEM survey from the fourth construct, careers, fell into similar ranges as the constructs focused on STEM content. Five careers were rated by students in the survey. They were medicine, engineering, computer science, Earth science, and mathematics. Each of
these career fields was explained in a short paragraph (see appendix D). The highest rated career interests for the female students were engineering (80%), Earth science (70%), and computer science 66%. The lowest two were mathematics (58%) and medicine (56%). For male students, the highest three careers were computer science (79%), engineering (76%), and Earth science (63%). The lowest two were also mathematics (60%) and medicine (49%).

The largest increase from the pre- and six-week post survey for all female students was in medicine with a 14% increase followed by Earth science at 12%. Similar growth results were found for males. However, significantly, for female students new to camp, engineering and computer science both had the largest increases at 23% and 18%, respectively. Interest in computer science and medical careers was also high for new to camp male students at 20% and 14%, respectively. Also important to note, all survey questions returned positive results in this career construct for female participants.

During observations, it was clear that each camp had a similar format in which general information was shared, teaching occurred, and a plan for the session was outlined. Following this first period of time, students began working on projects independently, in pairs, or small groups. During this work time, camp instructors would circulate and ask students questions and help support them. Periodically, instructors would gather the entire class together to address a common misconception, concern, or to share a strategy or insight gleaned by an individual or small group.

It was typically during the initial whole-group introductory lesson or when the instructors pulled the whole-group back together for a mini-lesson that careers where discussed. For example, in the *Kids Love Construction* camp, the instructor discussed architects, general contractors, plumbers, engineers, electricians, HVAC, finish carpenters, and concrete workers.
These careers were discussed relative to the student projects for that day. Students had opportunities to ask questions as well, such as, “Do you go to college to be an electrician?” or “What exactly does a plumber do?”

Some camps, such as Camp Crime Scene, used PowerPoint slides to share career ideas. Each camp had an instructor guide which included instructions to discuss careers as well as example, related careers. Below, instructors share their interest in additional resources.

In this category four out of the six participants discussed pursuing STEM careers. All of them discussed the importance of STEM and related it to their chosen field (e.g. Emma). During their second interviews participants were more specific about their career aspirations and how STEM knowledge would support their aspirations (e.g. Cecilia and Sophia). Survey data corroborated their growth and interest in STEM careers, particularly for participants new to STEM camp, both female and male. Not surprisingly, engineering and computer science showed the highest gains for female campers as the majority of camp sessions focus on these areas of STEM. In the next session data related to this same theme are shared from the instructors’ perspective.

**Instructor Value of Content and Careers**

Staff also spoke to the value of STEM content and subjects for this student population. Their focus, however, was different from that of students. Staff tended to speak about the importance of experience to STEM content rather than the value of the content in and of itself. Several spoke to the importance of maintaining learning during the summer as well. One staff member, Julie, reflected:

I think they are benefiting a lot. I think they see things that they don’t normally see, like the Lego robotics for example. And I think at the basic level, just that exposure. They’re
going to go to school and be like, wait, I remember this. And this is something that I would be interested in. And then, they’re more likely to get involved.

The camp director also spoke about the experiences students were being afforded, particularly for female campers.

I think they get to see how fun the science things are, that they don't normally want. Not want, that's not the right word. They don't normally market or try and get girls into, so they don't see that part of the world. And I think just being able to expose them to that and they get see how fun it is to watch Mentos drop into a Diet Coke bottle or, Camp Crime Scene sounds awesome, I would've loved to do that when I was a kid.

Another instructor, Karsten, spoke to the importance of the camp experience for students who received a four-week scholarship from the district’s Title I program, how that influenced her decision to participate as an instructor and how the experience can reduce opportunity gaps between students. The first year the program was offered students could attend all four weeks of camp. In subsequent years only one-week scholarships were provided. Here she speaks to her experience as a camp instructor at an all-girls session called *Girls Love Legos*:

So, I just knew it was a good program and I wanted a summer job. But then I kept coming back because, I realized that it was more than just, I'm getting paid to work in the summer, it was important for these kids to be here; especially the kids the first year that I worked with who were getting to go to camp for four weeks for free. They got a really cool experience that they don't get often or ever. And so, that was kind of why I came back and then every year it's just grown on me that it's important to them, and it's really essential for their summer learning. And if you don't give that to them and you don't have
people who are willing to put time into that. Then they're just gonna stay behind everyone else. I wish everyone in the U.S. had it; so I'm definitely promoting the program.

Garcia talked about the value of the learning experiences that she has witnessed firsthand in the district’s preschool STEM camps:

Because it's so much fun, it’s so cool, and it's so cool to watch kids just light up, when they figure something out. I loved watching the preschoolers. And watching them come out and talk about the dinosaurs, and she'd go out and put masking tape on the big wall, at Montessori. And there's the big dinosaur, and you've got the little kids next to the big dinosaur, or the catapults. I have a really awesome video of a little girl, and she had her marshmallow catapult. And she's staring at it, and she launches it, and her face just becomes the coolest, whoa. You can just see her mind just exploding with that marshmallow, and you can't get that anywhere else.

The instructors also spoke about careers both during interviews and to their students during camp sessions. Some camps had PowerPoints which listed careers such as Camp Crime Scene. Each camp has an instructor guide which includes instructions to discuss careers as well as example, related careers. However, some camp instructors, such as Julie here, expressed an interest in having more support.

It’s good and kids are getting great exposure and some of these things, kids have never seen before. All that is great, but I think being able to tie it a little bit more to careers, and just having a little bit more of the resources so that you can hit the ground running.

Similarly, Karsten discussed being more explicit in our discussions with female students about the connections between what their learning and STEM opportunities in their future.
I think they see it, but I think it needs to be more like told to them. Today, we had a conversation with our girls about it, and like STEM and why it's important for them to continue in STEM, and make sure that girls get in the robotics classes and all that stuff. And they seemed like they hadn't really heard that before, so that was good that we had that conversation. But I think they see it.

Then Karsten went on to say,

We ask them why is the camp called *Girls Love Legos*, and not just *Kids Love Lego's*, and they didn't really connect the dots. Then when we told them, they were like that makes sense. So, I think if people tell them and they walk into this camp and know why (they’re) here, then it would be easier for them to get the full picture.

Instructors did not explicitly point out that technology is a tool for students to learn on their own during interviews or during observations. They did make statements, such as, “Wherever you go, you can use this later on.” However, in almost every camp session observed instructors showed students how they could access the online programs themselves at home and after camp. They showed students how to create accounts, so they could save their work and access it from any internet connected computer.

In this section data related to the theme of the value of STEM content and careers was shared, the *What*. It was organized into three categories, the value of STEM content, careers, and technology as a tool for learning. In the next session data related to the third and final theme of Who, the intersection of camp experiences and participant identity will be shared.

**Who: STEM Camps and Participant Identity**

Throughout the interviews students and staff spoke of camps and camp activities relative to their interests, identity, and sense of belonging. Student and staff exposure, or lack thereof,
was also a sub-theme, or category in the data. Below data from interviews related to both categories will be shared related to the third theme of Who.

**Belonging**

When the female participants were asked about camp and how they felt about it the vast majority felt welcome (see above). A few did comment during their initial interviews on being unsure at the outset of camp or on the first day, if it was their first-time attending STEM camp. By the end of camp, all participants reported feeling like they belonged. For example, “I actually felt very welcome, comforted, whatever you call it. I felt really happy, like I belonged here.” Another participant related, “I’m really happy here, I like it a lot. I think the kids are nice, the teachers are nice. It’s really fun.” Others were more ambivalent, “I’ve never had a bad experience here.” Sophia reflected during her second interview about her first day and not knowing what to expect, “I just felt a little scared when I was first coming here because I didn’t know what was going to happen.” Ava said she felt good because she had friends at camp which helped her feel more comfortable, “Good because I have my friends with me.” Another participant, Hayden, felt similarly. When asked if she felt welcome she said, “Kind of, it was kind of new to me, I’ve never been in here, even though we always pass here when we go to drop of my siblings. But yeah, I was kind of welcome.” When asked how she felt now, she said, “Yeah, because I always see Kira. When I first met Kira, she and I were both lost. We didn’t know what drone operators were. And so, we just sat down and waited at the table and we become friends.”

Many student participants also talked about how they have always had an interest in STEM. For example, Emma shared, “I’ve always been into science and outer space and stuff.” Ellie said, “I’m really interested in how things work.” Still another, Ava, “I’m one of those
people that like to build.” This last statement was representative of others that made it sound that this interest was innate or predetermined. For example, Anastasia stated:

    I feel like if I was put into an engineering field I could do quite well. I have a creative mind, is what most people say. But really, if you give me a problem to solve and I need to make something to solve it, it will take me awhile but I’m sure that if I test it in my head, it’ll normally work.

    While the participants shared they felt welcomed to and interested in STEM camp several suggested that camp leaders should add additional camps that might be of more interest to girls that have yet to attend. Janessa said it this way:

    Maybe get more girly stuff, I guess, and different camps for different genders. It doesn’t really matter what gender as long as you’re interested in that. I know some kids are interested in acting. Maybe they could fix stuff also. And then you also could try powering and light by energy and stuff.

She went on to say, “I know there’s that *Girls Love Legos* for girls. I’d suggest that because it’s girly but it’s kind of both.” While she did not attend a camp which she described as girly, she could see that these camps could attract some girls that might not otherwise be interested. Some participants were frustrated with girls who did not take camp seriously or who were not interested in STEM for its own sake. Anastasia shared her thoughts when asked how camp administrators could attract more female campers:

    Well actually it is a bit annoying, I see where you're going, but it's sort of hard because lots of girls are into different things. And I know one thing for sure, lots and lots of girls are into makeup. So, if you show them the science behind the makeup, maybe it'll get them into science a bit more or the science, or how you make clothes. Cuz lots of females
are into what you're wearing, what makeup you have on, how your hair looks, how hair dye works. A lot of females would be into that. Show them the science in their daily routine.

Other participants seemed unsure if some STEM content or careers were of interest to them. When asked about engineering, Cecelia shared, “It seems interesting, but like, it’s not my cup of tea. It’s just something that I’m not really interested in.” However, it was not clear if she understood what an engineer does because later in the interview she said she enjoyed building things and that she wants to be an architect. Two others said something similar about mathematics, but none said they were not interested in science or technology.

One sub-category that emerged from the student interviews was their interest in using what they know to help others. This data was typically shared when participants were asked about their career interests. For example, when Anastasia was asked if her future goals involved STEM she said, “Yes, I want to be a marine biologist. I want to be a marine biologist because I love the water. I love swimming and also I feel like if I can save all the animals in the world.”

Emma spoke of working in the health industry, “I want to work in the emergency room because I am curious about what happens, and I really don’t like people to get hurt.” Another spoke of work in law enforcement to help others, “I wanna help people. I wanna make sure that people are safe and teach people.” Still another, Ava shared she wanted to be, “a vet because I want to help animals.” Later when talking about the importance of STEM knowledge she said, “You can learn to save a person’s life.”

A final sub-category to the category of belonging and interest was the social component students discussed during their interviews. During her second interview, Hayden, when asked about her best experience at camp talked about time with her camp instructor and another
student, “The (best) experience that I’ve had was just being able to (be) with my camp teacher and then another student.” Janessa said something similar when asked the same question, “Last year I did VR and that was so fun. I met my first best friend in Spokane and we had so much fun. We’re still friends.” And still another, Ava, “Making new friends, like Cecile and Jerra.” Anastasia talked about how other students can be helpful, “We have people helping us. There are other kids helping. I feel like that helps.” Some participants talked about the difference between male and female campmates and how working together was valuable. Anastasia explicates below:

Probably it was my first year at STEM camp and I was put in a group of females. It was amazing. We’re all females, we think alike, sort of. Because females, we have similar ideas because we are the same gender. Boys are sort of always like, I want to do this. I’m gonna do it. I don’t care what anyone says. Us girls are like, well some girls, you want us to do this, well let’s think about what we can do. You put a problem in front of us we can easily solve it together. There’s more of a chance that we will solve it correctly if there are more of us than just one. Like, Ellie was helping a lot. She was helping think through why I was getting frustrated with the computer. She would help.

In this section students discussed feeling welcome and interested in the STEM camps and its content. They shared factors which contributed to their positive experience such as how the content related to their interest in helping others as well as the social aspect of camp and finding friends with similar interests. Lastly, they shared that that some girls, but not them, may benefit from camps that are more gender stereo-typed, what one described as ‘girly’. Next, we will turn to the second category in this theme which focuses on students’ ability to have meaningful experiences related to STEM.
Exposure and Opportunity

Another category that emerged from the theme of identity was exposure or the lack of exposure to STEM careers and subjects. This category was strong in both the student and staff interviews. As in other sections, I begin with student interview data and then conclude with staff interview data.

Past experience and exposure to STEM content or career knowledge varied widely for both students and staff. For example, some students had attended STEM camp for several years or had parents who worked in STEM fields. Others had been provided a scholarship to camp and had few STEM related experiences other than use of consumer electronics and their core school math and science instruction. Even then, some students reported that their access to science was limited. For example, Ellie, a fifth-grade participant shared when asked how much science her class did last year, “Not that much, but we did some. Maybe three projects.” When asked how much time was devoted to science in a week she said, “Zero. Maybe once a month?” Anastasia reported similar exposure:

Well there's a couple of years in elementary, you don't do much science experiments. So we actually, in sixth grade, we actually didn't even have science. We had science in our classroom. And on the experiments, we were trying to sort of do maps. And that's all I can really remember is doing some maps. Making some clay float, but that's all. This participant went on to say that through the camps over the years she has had an opportunity to be exposed to STEM opportunities that will be valuable. When asked if participating in STEM camp over the years will help her pursue her goal of being a marine biologist, the participant stated, “Yeah, definitely because they sort of taught me things that actually a lot of people don’t get to learn until they are going into that field.” This student was able to learn about STEM
careers and subjects at camp despite minimal science instruction at school. She was not alone. Emma stated, “Yeah, we do science. We learn about electricity and stuff. It’s more artsy than sciency. We would color pictures and redesign photos that we have seen. To me that’s more artsy.”

Other students struggle to pay for STEM camp even with scholarships. Some students in the district received one-week scholarships from the Title 1 department. Cecelia shared she was interested in becoming a police officer. When asked if she was going to sign up for the Camp Crime Scene camp she shared, “I really wanted to do that, but they only were paying for one week. So my mom said maybe I could do that.”

Even students who were interested in a STEM field appeared to have a lack of knowledge and exposure to STEM careers and opportunities. Sophia, who had shared she wanted to be an electrician, when asked if she had heard of the jobs or terms computer programmer or software engineer said, “No, I have not.” Alternatively, other students had the benefit of families who had the means to provide their children with STEM opportunities. For example, Janessa responded to the question of why they wanted to pursue a STEM career this way, “It runs in my family.” Hayden said, “When I grow up, I really want to be an electrician like my dad.” Staff also spoke about the importance and lack of exposure to STEM. All the instructors also talked about their own access and exposure to STEM opportunities. These data will be shared next.

**Instructor Identity and Exposure**

The female camp instructors also spoke to this category talking about student interests, role models, and differences observed at camp between boys and girls. They also discussed the impact of teaching at the camp has had on them. Karsten shares her thoughts here:
I think my main takeaway for female students is that, it's really important for them to see that girls can do what the guys are doing. So, we can be in the same classes as them and program the same robots as them, and it's not just a guy thing to go into science or to do that kind of stuff. Kids just kind of picture stuff that's attainable, but then they're like it's just a guy thing, guys are scientists. But it's really important for girls to see at a young age that being smart is cool and it's important, and you shouldn't just like ignore that. But also, that you can use that any way you want.

Similarly, instructors, just as Julie, felt that camp instructors needed be more explicit in making connections between the camp activities and careers and subjects:

I think they see it, but I think it needs to be more like told to them. Today, we had a conversation with our girls about it, and like STEM and why it's important for them to continue in STEM, and make sure that girls get in the robotics classes and all that stuff.

And they seemed like they hadn't really heard that before, so that was good that we had that conversation. But I think they see it. They just don't quite understand yet.

Another instructor, Garcia, shared that the female students came into camp with less confidence but leave with more confidence:

I feel like a lot of the girls that come, they start with this reservation, that they're not necessarily as confident as the boys are. But they're still there, so they made the effort to get there. And the more they get through the week, and we had a lot, I feel like, this year, who came all four weeks. So, if you're coming all four weeks, then you realize that you have so much more to offer. And when you talk about, there's a lot of parts in the curriculum for camp where you get to talk about, where this can go. That teaching-for connection, where you go, you can use this later on. This isn't just something that you did.
in camp, when you were going into fifth grade. It's something that you can take, and really see that it's gonna take you somewhere. I was really excited my first week was mostly girls, mostly going into sixth and seventh grade. And to know that they were still interested in that math and science world, where normally, at that age, you see that they’re not as interested.

And they were fully engaged, and they were there and ready to work. It was really cool, to know that we're fueling that fire, and it's not getting squashed other places. They're still into this, and they still really want to be there. I think you can tell that the girls, there's no difference, I'm no different than them (the boys), this is what I wanna do, that's why I'm here, what's the big deal?

Another instructor who has taught camp for several years observed the experience of students who have also attended year after year:

They've gone through the preschool camps, and now they're in big kid camps. So, they're in coding, they're in chemistry, and they've grown up with that. And so, science, and math, and STEM is just part of what they know, it's normal to them. And I just, I want all kids to know that it's normal, you can do it, there's nothing saying you can't do it. There's no cutoff, there's no gate, there's nothing holding you back, and it's just part of what you do. I can’t wait for more kids to have that as they cycle through.

Others, exemplified here by Julie, talked to the benefit of role models, “I think just seeing the female teachers here, a lot of the kids when they see somebody like themselves doing something, they’re more likely to be engaged in it. So, I’ve noticed a big difference in that.”

Through teaching at STEM camp, instructors became more aware of its importance for students. The director shared, “I think at the basic level, just that exposure, they’re going to be at
school and be like, wait, I remember this. This is something that I would be interested in.” After teaching at camp for several years one instructor, Karsten had a realization:

I realized that is was more than just work in the summer. It was important for these kids to be here, especially for those who were getting to for four weeks for free. They got a really cool experience that they don’t get often or ever.

Julie shared her thoughts on the importance of providing these opportunities to female students this way, in response to a question asking if she would bring her own daughter to camp one day:

I think you can teach your kids a lot at home. They can't get the same learning that they get in this kind of camp. You can tell them all you want, ‘It's cool to be smart’ and ‘It's cool to go into science or math.’ But they're not gonna ultimately listen to you because they're gonna decide for themselves, based on what's around them, what they're exposed, to, and what other people tell them. So, I think that if they're in an environment where other people are also interested in the same things and think that it's cool and promote actively working on this kind of stuff, they're gonna be more apt to be like, I'm interested in this rather than surrounded by a bunch of boys and I'm like well I'm just coming in to sit here, so yes.

The instructors spoke above to the power of STEM camp experiences for the campers. They spoke to the unique opportunities for exposure and seeing role models in the form of instructors and other students. Another sub-category that emerged from the instructors’ interview data were changes to the instructor’s view of STEM and how they teach. While not a primary focus of this study, it is relevant to the topic given that all instructors interviewed were female and serve as role models both during the summer and throughout the school year. When asked if
working at the summer camp changed how they felt about STEM all instructors and the director indicated that it had an impact. Karsten said:

   It definitely has. It’s really cool to see kids who already know so much about science and all this stuff at such a young age, that I wish I would have known. I think it did kind of inspire me a little bit to just try everything and not avoid the stuff that I think I’m bad at. If all these kids are programing robots at age five, then I can probably go through a biology class.

The camp director also spoke to having these experiences or knowledge at such a young age, “I think just being able to expose them to that, they get to see how much fun it is. I would have loved to do that when I was a kid.” Another instructor, Julie, also indicated she would bring her daughter to STEM camp and that her own perspective was changed:

   I completely would. When you were just talking, I was thinking about ‘why I didn't go into STEM?’ And I think it was just, you don't see many girls in a lot of these fields. And so, they were just never an option really. We watch TV and you see things and you're going places, and it's mostly men and watching this stuff now, I'm like, ‘Why didn't I do this? This is so interesting.’ I think as I grew older and I never got into it, those doors were kind of closed, in my mind. So, yeah, if I had a daughter, I totally would. Just to keep those open, I mean, she doesn't have to. But just to be involved with it and say, okay I'll try this.

Julie, who is African American, went on to share her experience with STEM growing up:

   I felt like I never had the experience to try it. And so, I was less likely as I got older to be like I'm gonna try this now even though I've never seen anybody (like me). I knew the boys went into the computer stuff and girls weren't really interested. There was never a
push at school for that, never. Boys are more mathematics and science, and everything was messy, and boy-related. It just was very gender-related, and I felt like if I was the black sheep that went to the other thing I would stand out.

Later, when reflecting further about her career choice the same instructor shared it was more difficult for her to choose a STEM career as she got older:

And as I got older it got harder. But I mean, that's why, at first, I wanted to be a dental hygienist in high school. And I was intimidated. And so, I was like you know what? I'm not going to do it. And then I went to psychology.

When asked about how working at STEM camp has changed how she feels about STEM subjects she had this to say:

Yeah, I've been a lot more aware and when I'm talking to people especially at my other job, and I'm talking what do you wanna do when you grow up? I watch the way that I would suggest things, it was very gender specific, I noticed that in my own thinking. And so, I've started to really keep them invested in like math is great. Science is great. It's okay to feel nerdy. It's okay to like those things, and be different, and not mesh where you think where you belong but where you actually are.

In reflecting on how teaching camp impacted her, Julie went on to share she might do things differently if she knew what she knows now and could go back in time:

So, I have, I've started looking at situations differently and being more open to it. Yeah, kind of just like why didn't I? If I could go back in time probably, would've cared a little bit less of being different and just going for it. Because yeah, I was good at it.
Another instructor, Garcia, shared how prior to teaching at STEM Camp and afterschool robotics clubs, she had limited exposure to STEM. She spoke to how she views STEM content, or subjects, rather than careers:

Prior to starting in STEM camps, I had a very fixed mindset about math and science. I would tell you I was not a math or a science person. I only took one math course in college, and it was for elementary educators, it wasn't even an actual math course.

And I took only the elementary science class, so I didn't take any math or science classes in my undergrad. And my master's degree is all about behavioral health and social health. So, no math and science, really, there either, except for statistics. So, until I started doing STEM camps, and robotics, and all that stuff, I was really not involved in math and science.

Then Garcia went on to share about why she continues to teach at STEM camp, “There are things that I never would have let myself experience, unless it was at STEM camp. I wouldn't have entered this world by myself, but now that I'm in it, I don't want to be anywhere else.” She went on to share how this has impacted her view of teaching STEM subjects:

Yeah, it's just knowing that it's not as, intimidating as it sounds, right? I've always had that in my head, science. I was always afraid of messing science up; I was always afraid of doing it wrong. And everyone's like, well, it has a procedure, it has the steps.

I was like, yes, but you have to do the steps right. And I was so afraid of failing, that if I didn't do one step right, then the rest of the steps were meaningless. And so now that I know that process of, it's okay if that step goes wrong, you just go back to the beginning and try again. And I feel like I could.
And I know I'm definitely more confident in teaching math. Which is really interesting, because I really haven't done any math-oriented (camps), other than coding for robotics. But just knowing that it's not a scary thing, and until you make it scary, kids don't think it is.

In this section data was shared related to the third theme which emerged in this study: STEM camps and Participant Identity, the Who. This theme included two categories, STEM Exposure and Opportunity and Belonging and Interest. This data was taken from participant interviews which occurred throughout the STEM Summer Camp.

While participants felt welcomed by the conclusion of STEM camp, several indicated that some females not in attendance may not. They suggested creating camps that might appeal to a more stereo-typical, gendered female student. Two expressed interest in STEM but still preferred non-STEM professions. There was evidence that exposure and opportunity was mixed. Some students had parents who worked in STEM fields while others were unsure of what engineering meant. Students also expressed an interest in STEM careers which could be leveraged to help others, including animals.

Instructors spoke to the importance STEM camp in reversing then gender-based stereotype threat. They expressed that over the course of camp they saw female participants gain confidence with STEM content and subjects. They expressed the importance of girls having role models in adults and fellow peers in helping them normalize STEM content and careers as something that girls can do and do well. Finally, instructors talked about their own journey and how they grew up feeling that STEM subjects and careers were reserved for men or those that were different from what was expected of them as women. They also talked about their lack of confidence in mastering STEM content and courses and their lack of exposure to them in their
post-secondary education. They shared how teaching and STEM camp helped them see what they were capable of and that STEM content and careers were indeed open to them and something they were good at. Some even expressed that if they could go back, they might pursue a STEM pathway. In conclusion, they expressed how they are now working to ensure they encourage the next generation of girls to pursue STEM and see it as an option that is open and available to them should they so choose.

In this chapter data from interviews, observations, and surveys were organized into three themes. In addition to the third theme shared above, there were two other themes shared in this chapter. The first theme was constructivism and agency, or the How. This theme was comprised of two categories: constructivism and agency. The second theme was the What, or the value of STEM content and careers. This theme included the categories of STEM Content, STEM Careers, and Technology as a Learning Tool. Finally, the third theme was related to the Who: STEM camps and how they related to participant identity.

Students had much to say about STEM subjects and careers during their interviews and via the survey. Students indicated the inherent value of science and math content. They discussed how they enjoyed the active nature of STEM activities and learning, and that technology is a tool for learning. In addition, they spoke to their past experiences and how STEM subjects and careers aligned or didn’t to their own future aspirations. Survey results indicated increases in student interest in STEM careers in all five categories of medicine, engineering, computer science, Earth science, and mathematics with engineering and Earth science being the highest. Student survey data indicated that students’ views of STEM content improved over the course of the STEM camp and maintained for a minimum of six to eight weeks. Math and science, when compared with engineering and technology, proved more resistant to change. Camp instructors
spoke to their interpretations of the student experience at camp as well as how being a camp instructor impacted their own views and perceptions regarding STEM subjects, careers, and instruction. Camp instructors expressed the value of choice and agency both in choosing the camp itself and having choice within the camp experience. In contrast to students, who clearly identified STEM content as important for current and future learning as well as for careers options, staff focused much more on the value of the STEM camp experience in terms of exposure rather than learning math or science content or how to code, for example. They spoke to how their view of STEM changed and its impacts upon their own instruction.
CHAPTER FIVE: DISCUSSION AND IMPLICATIONS

As mentioned earlier, this study was conducted to explore preadolescent beliefs and attitudes regarding STEM subjects and careers. The following research questions provided a frame for this study:

1. What are the views and perceptions about STEM subjects and careers held by female preadolescent students at the fourth, fifth, and sixth grade levels at a STEM camp?

2. What are the perceptions about STEM subjects, careers, and instruction held by female instructors of the fourth, fifth, and sixth grade level participants at a summer STEM camp?

3. How did preadolescent students’ attitudes and perceptions change regarding career aspirations and interest in STEM subjects, courses, and clubs?

The final chapter restates the research problem and reviews the major methods found in this study. The primary sections of this chapter include a discussion of the findings, their relationship to prior research and the study’s conceptual framework, and implications for practice and future research.

Statement of the Problem

The United States K-20 educational system does not adequately prepare enough students for the twenty-first century. Many students do not have the opportunity to pursue STEM degrees because they are not adequately prepared. Many others, particularly female students and students of color are choosing not to pursue STEM careers even when well prepared to do so (Bureau of Labor Statistics, 2014; College Board, 2013; NCWIT, 2016). In fact, between 2000 and 2014
seven percent fewer first year university women indicated they were interested in pursuing a STEM degree (NCWIT, 2015).

By the time students reach high school many have already decided that STEM courses and careers are out of reach (College Board, 2013; NCWIT, 2016). Most research attempting to discover the programmatic impacts of STEM initiatives focuses at middle or high school level (NSTC, 2011; 2013; NRC, 2013). We know that students start making decisions related to their future and how they see themselves in relation to STEM domains and various career clusters much earlier (Linver, Davis-Kean, & Eccles, 2002; Weisgram, Bigler & Liben, 2010). More research studying the impacts of STEM efforts during and after the traditional school day at the elementary level is needed.

**Review of the Methodology**

This study was qualitative in nature. This study employed a qualitative-convergent parallel design. The research questions sought to understand inductively how a one- to four-week STEM camp impacted preadolescent girls’ self-perception and interest in STEM subjects, content and career interest. Data was collected and then analyzed for themes and categories using data from interviews, observations, and surveys. Both camp participants and camp instructors were interviewed throughout the month; students twice and instructors once. Observations of primary student-participants were conducted following initial interviews. Final interviews of campers occurred the last day of their camp experience. Student participants participated in a STEM survey which asked about their interest in STEM subjects and careers. The survey design was semi-longitudinal, meaning the data was be collected over time. All Spokane Public Schools fourth, fifth grade, and sixth camp participants at the research site took the survey three times.
First, before camp began, second, just after the final camp session ended and third, six to eight weeks after the final camp session ended.²

**Discussion of Research Question Findings**

In chapter four the data from this study was organized by themes which inductively emerged from the data itself. The themes explicited how camp students and staff described their experience at camp and what types of experiences they preferred. Next, I conveyed data from participants related to what content and careers they valued. Lastly, data related to how the content and experiences related to who the camp participants and instructors saw themselves to be was shared. In this section, the findings from chapter 4 will be discussed in relation to the study research questions and the study’s conceptual framework.

**Research Question One**

The first research question was, *what are the views and perceptions about STEM subjects and careers held by female preadolescent students at the fourth, fifth, and sixth grade levels at a STEM camp?* Students had much to say about STEM subjects and careers during their interviews and through the survey instrument. Students indicated the inherent value of science and math subjects. They discussed how they enjoyed the active nature of STEM activities and learning, and that technology is a tool for learning. In addition, they spoke to their past experiences and how STEM subjects and careers aligned or didn’t to their own future aspirations.

**STEM Subjects**

Students clearly emphasized the importance of the subjects of science and mathematics. They shared how these subjects are foundational to other learning and for use in future careers

² For a full description of the methods used in this study see chapter three.
and to society in general. Students had more positive feelings and enjoyed science instruction more than mathematics. This was true in both the interviews and the surveys. However, students seemed to understand the value of mathematics despite not enjoying learning it or feeling as confident in mastering the content.

A strong finding was students’ preference for active learning opportunities in which students had choice, or agency. The student-participants noted how science instruction was somewhat limited during their school experience but that STEM session lessons were interactive, engaging, and included choice. They described an inquiry experience in which they discovered and uncovered rather than were told and asked to repeat what they had learned. They shared how STEM camp encompassed the attributes of being active and provided agency. In addition, students shared that the environment of learning was fun and contributed to their learning of STEM content. In other words, these two ideas were not mutually exclusive. Students also spoke to the fact that technology is a tool that they use to learn other content, including STEM content. These findings suggest that schools and districts could improve female students’ interest in STEM subjects by ensuring instruction is constructivist in nature, meaning that teaching and learning is active and inquiry based rather than delivered via a more traditional lecture-based format.

On the STEM survey, students’ attitude towards engineering and technology was the highest of the three constructs focusing on STEM subjects, math and science being the other two. Student attitudes started higher in this construct and this result was consistent in the second and third survey administrations at the conclusion and six to eight weeks following the STEM camp. In general, male affinity for STEM subjects and careers was strong based on the initial survey results. Female students new to STEM camp showed the most growth of any group over the
course of the camp. These results maintained six to eight weeks after camp. This may suggest that STEM camps such as this one may be most beneficial for new campers, especially females. Males new to camp did not show the same dramatic growth as females. Therefore, STEM camps have the potential to be used as a gap closing strategy between young men and women.

**STEM Careers**

Students also showed interest in STEM careers. Four of the six student-participants expressed interest in pursuing STEM-related careers. Those that did not still spoke to the importance of STEM content knowledge in pursuing their own careers paths. For example, one student shared how she would need STEM content knowledge in order to run a farm, her career of interest. It would be beneficial for schools to leverage student STEM career interest at this young age during instruction of math and science subjects by making explicit connections between the subject content and STEM careers. Students appeared to have limited exposure to STEM careers outside of their own familial experiences. For example, one student did not indicate an understanding of engineering, yet discussed having an affinity for building and creating. Instructors shared similar insights regarding students’ prior interest and experience pointing to the importance of female role models and STEM camps like the one under study. Without explicit attention to and discussion of STEM careers many students may not know about them and thus may not pursue STEM course pathways or STEM careers.

Observations indicated that camp instructors did make connections between the camp lessons and STEM careers but that more explicit supports for instructors would be beneficial in supporting this interest. Districts would do well to provide explicit professional development in the area of STEM careers for teachers. Curriculum directors and coordinators could also embed STEM career information into program and curricular guides used by teachers. In addition,
schools and districts should leverage existing college and careers efforts, which are common, and ensure STEM careers and pathways are understood and shared with staff and students.

Students also spoke to the connection between STEM careers and their own interests. Specifically, students spoke to the fact that they wanted to help others through their careers. When discussing STEM careers they discussed how they could use what they have learned to help others. Others spoke to feeling like STEM and STEM careers were a natural fit for who they saw themselves to be and what they were good at. As an example, one student talked about how others perceived her as a good problem solver and how this made STEM a good fit for her. These findings were consistent with the literature and will be discussed further in the relationship to the previous research section. Like other subjects, it is important to connect learning to students’ prior experiences and current interests. In this case, STEM career connections can and should be made with students’ interests in helping others and improving our communities and the larger world.

Finally, survey data showed a majority of students had interest in STEM careers. This was true for both males and females and both students new to camp and returning to camp. While interest in specific STEM career pathway varied female interest was positive for all career questions. Similar to STEM constructs regarding STEM subjects, female student-participants new to camp showed the most gains on the survey regarding STEM career interest. Several of the female campers originally started attending due to camp scholarships. This is a strategy that may need to be expanded to attract students who may not otherwise attend. Again, schools should leverage this budding interest and both encourage and build upon it during the school year. Curriculum textbooks rarely make these connections so districts will need to support teachers through professional development and program guides.
Research Question Two

The second research question was, *what are the perceptions about STEM subjects, careers, and instruction held by female instructors of the fourth, fifth, and sixth grade level participants at a summer STEM camp?* All three camp instructors and the camp director had participated in teaching or leading the camp for two to four years. Camp instructors spoke to their interpretations of the student experience at camp as well as how being a camp instructor impacted their own views and perceptions regarding STEM subjects, careers, and instruction.

**Instructor View of Teacher Experience**

In addition to instructor views of the student participant experience at STEM camp, this section will outline the instructors’ experience as camp leaders of young students. They spoke to how their view of STEM changed and its impacts upon their instruction. While not a primary focus of this study, it is relevant to the topic given that all instructors interviewed were female and serve as role models both during the summer and throughout the school year, both of which have implications for improving STEM education in public education.

First, instructors talked about wishing they had more STEM experiences as young students. Specifically, the STEM experiences afforded to the students at the SPS Summer STEM Camp. They also commented on how they did not have these opportunities and if they had, they might have pursued a STEM pathway. They shared these comments in the context of how beneficial they felt the experiences were for the student-participants under their care. At times they expressed amazement of what such young students at camp already know and can do.

Similarly, the instructors and camp director talked about how STEM was positioned as something for boys, and not girls, when they were growing up. They said they did not know or see girls pursuing STEM, only boys. They talked about messages from mass media, such as on
T.V., portraying STEM as gendered as well. For example, one said, “I knew the boys went into the computer stuff and girls weren’t really interested.”

In addition, through the act of teaching at camp instructors’ view of STEM subjects and careers changed and opened up. Instructors talked about making different collegiate and career choices if they knew what they know now and could go back. They shared how the young campers inspired them and helped them have more of a growth mindset. They seemed to see teaching STEM subjects in a more inquiry driven, constructivist manner. They talked about not being worried about making mistakes and trying new things. For example, Garcia shared, “Prior to starting in STEM camps, I had a very fixed mindset about math and science. I would tell you I was not a math or a science person.” She went on to share, “There are things that I never would have let myself experience, unless it was at STEM camp. I wouldn't have entered this world by myself, but now that I'm in it, I don't want to be anywhere else.” These and other instructor comments seem to indicate that teaching at a STEM camp build instructor confidence, awareness, and openness to teaching STEM content. Next, instructors’ views of the student experience will be discussed.

**Instructor View of Student Experience**

Similar to student-participants, camp instructors expressed the value of students having choice and agency both in choosing the camp itself and having choice within the camp experience. They contrasted the STEM experience with teaching science, math, and technology during the school year. They shared four points. First, students could focus deeply on one or two ideas or projects rather than “cover” content in a more even, whole-group fashion. That campers could focus on a bigger idea and pursue their interests rather than march through predefined subject or content standards. Second, that students enjoyed, and preferred, the active,
constructivist learning and teaching style of camp to a more traditional and passive learning style found in much of their public education experience. Third, instructors talked about inquiry and that a critical aspect of the camp was helping students explore topics deeply and allowing them to struggle. They talked about not providing campers the answers and letting them problem solve independently and with peers to solve problems. Finally, they spoke to their own feelings and thoughts related to STEM learning and instruction and how camp impacted their conception of STEM teaching and learning. This will be discussed in the following section.

In contrast to students, who clearly identified STEM content as important for current and future learning as well as for careers options, staff focused much more on the value of the STEM camp experience in terms of exposure rather than learning math or science content or how to code, for example. Instructors spoke to the fact that for many female campers, STEM camp might be their first and only STEM experience. In fact, they said things like, “You can’t get this anywhere else” and, “They got a really cool experience that they don’t get often or ever.” They talked about how students were able to make connections and that students’ minds were opened to possibilities. One instructor said it this way, “She’s staring at it, and she launches it, and her face becomes the coolest, ‘whoa.’ You can see her mind just exploding.”

Two of the four instructors felt that while students were getting great exposure to STEM experiences and female role models, camps could be improved by helping instructors be more knowledgeable and intentional making connects to STEM careers. The student data indicated that while participants were interested in STEM careers, their knowledge of STEM careers was limited. These findings align with previous research discussed above which has shown that teacher knowledge of STEM careers is weak.
Finally, instructors spoke to the importance of camp in helping female students feel that STEM courses and careers were options for them to pursue. Instructors spoke to the value of seeing female camp instructors as well as female peers at STEM camp. The instructors and the director all emphasized the importance of early exposure. They stressed capitalizing on the girls’ interest in STEM before they lost interest or society’s gendered messages influenced them away from pursuing STEM. One instructor said it like this, “They’re still into this. We’re fueling that fire and it’s not getting squashed in other places.” They seemed to indicate it was important to encourage girls to be encouraged to see past some of the cultural messages that STEM is for boys or that say girls should be a certain way. For example, Julie shared a message she tries to impress upon female campers, “It’s okay to feel nerdy. It’s okay to like those things and be different, and not mesh where you think you belong, but where you actually are” (emphasis mine).

Camp administrators and district leaders can leverage STEM camps to help female students pursue STEM interests and begin to see their interests and passions in alignment with STEM careers and subjects. The exposure to STEM subjects and careers at camp, including female camp instructors and peers, are key components to helping female campers see STEM as valuable and in alignment with their goals and selves. However, empowering female camp instructors appears to have benefits for more than just the female camp participants.

District and camp administrators can use this knowledge to improve STEM outcomes for their students. Having teachers serve as camp instructors seems to not only improve their own self-efficacy regarding teaching STEM subjects but also how they teach. Instructors spoke to their increased interest and confidence in teaching STEM subjects. Because they serve as role models for students all year long, this is a significant benefit. In addition, teachers discussed
moving to a constructivist, inquiry-driven approach. This aligns with research, and student data from this study, which shows students benefit and have more interest in STEM subjects when they learn in similar environments.

**Research Question Three**

The third and final research question in this study was, *how did preadolescent students’ attitudes and perceptions change regarding career aspirations and interest in STEM subjects, courses, and clubs?* Study data did indicate that students’ views towards STEM career and subjects did change over the course of their STEM Camp experience and six to eight weeks afterwards.

**STEM Subjects**

Student-participants seemed to arrive to camp fairly convinced that STEM content was important. They spoke to its role in helping them learn other content. For example, when talking about math several students made statements such as, “It is important to learn about math because it’s used in so many jobs. And you can learn many things with math,” and, “Science is mostly in everything, we need it for lots of things.” They also discussed the importance of science for helping with current environmental problems. Student interview data were inconclusive regarding changes to students’ perceptions of STEM content other than maintaining a positive outlook regarding STEM subjects found in the initial interviews. To further understand student participant perceptions of STEM content STEM survey data and instructor interview data will be discussed next.

Student survey data indicated that students’ views of STEM subjects improved over the course of the STEM camp and maintained for a minimum of six to eight weeks. Math and science perceptions more than engineering and technology proved more resistant to change. This
may be due to the camp’s focus on technology, coding, and engineering rather than on math or science content. Female students new to camp had the largest gains in STEM subject interest on the survey. Overall, female students new to STEM camp showed improved attitudes towards science in all categories when compared to the pre-camp survey and the six-week post survey. Significantly, these changes narrowed the gap between male and female perceptions of STEM content to one percent. This may be because male students new to camp indicated higher positive attitudes towards the content on the initial survey. These results indicate that STEM Camps such as the one studied here may be a productive strategy in closing early STEM interest gaps between male and female students. If these increased interests maintain, we would expect students to continue to pursue STEM subjects and electives in the secondary and post-secondary education.

While students who attended previously had higher average ratings on the pre-camp survey, 72% versus 68%, students who attended camp for the first time had the most growth at 10% when compared the pre and six-week post survey averages for this construct, STEM subjects. Overall, male students had higher positive attitudes towards engineering and technology when compared with female students. Similarly, students new to camp had higher gains, 12% compared with 6%, again, helping to close initial gaps found at the outset of camp. It is significant to note, that even at this young, preadolescent age, gaps between female and male students existed in both STEM content and career interest based upon the pre-camp survey. This would indicate that prior experiences and messages from the student-participants’ environment discourage rather than encourage their interest in STEM subjects and careers.

Instructors did indicate that female students were positively impacted by camp participation. They observed that female students sometimes entered camp with less confidence
with the STEM material then their male counterparts but left camp understanding that they are
capable and that STEM is an option for them. They emphasized that campers who attended camp
for two to four weeks had the most significant changes in perspective. This data seems to support
the survey data which showed a narrowing of the gap between female and male interest in STEM
subjects and content. The longer a student attends the greater chance they have to gain
confidence and be exposed to STEM content and observe female role models.

**STEM Careers**

Students indicated in initial interviews that they were interested in STEM careers. Four of
the six students stated in their initial interview interest in pursuing a STEM career in the future.
These students also indicated an affinity for STEM content. The two students who did not also
stated that while math was important for everyone to learn, including themselves, it was not a
subject they enjoyed. This was especially true when contrasting it with science. This might
indicate that mathematics is a key indicator for student STEM career interest and pursuit of
STEM subjects in secondary and post-secondary school. Over the course of the camp student
interest of careers did broaden and deepen.

When students were interviewed a second time their specificity grew. For example,
students who already indicated an interest in a STEM career in their initial interview were able to
more fully express their interest by providing more detail. One camper, Cecilia, initially listed of
several STEM career interests in her initial interview but when asked during her second
interview she narrowed down to one STEM career. The two students who did not indicate
wanting to pursue a STEM career did share the importance of knowing STEM content in any job
they chose. For example, one talked about the science and math she would need to run a farm
one day, her chosen career. While STEM career interest appeared to grow more nuanced, I did
not see an increase in number, or broader knowledge, of STEM careers by campers in their second interview. It would be helpful if camp instructors had additional training and professional development in STEM careers and pathways. STEM instructors only received one day of preparation before camp began. To improve participant exposure and understanding of STEM careers and subjects, it would seem important to ensure camp instructors first had that awareness and knowledge.

Survey results indicated increases in student interest in STEM careers in all five categories of medicine, engineering, computer science, Earth science, and mathematics with engineering and Earth science being the highest. The largest increase from the pre- and six-week post survey for all female students was in medicine with a 14% increase followed by Earth science at 12%. Similar growth results were found for males. However, significantly, for female students new to camp, engineering and computer science both had the largest increases at 23% and 18% respectively. These data seem to indicate that female students come into STEM camp with less knowledge about certain STEM careers. The career categories that showed the highest growth, see above, also represented a larger share of the camp sessions. In other words, camper interest grew for topics in which they were exposed. Also, important to note, all survey questions returned positive results in the survey construct of careers for female student-participants. District leaders and camp administrators may want to survey prospective campers in the spring prior to summer camp and create sessions to build knowledge and awareness based on low scores on the survey instrument.

**Summary**

Student-participant interest in STEM subjects and careers appeared to increase and become more nuanced over the course of the camp experience. Students came into camp
interested in STEM subjects and careers and left with a greater interest overall. They also began camp with the understanding that math and science are important but did not necessarily enjoy learning math. Though the experience at camp did show some increases in math and science interest, it was less when compared with technology and engineering. This may be because there was less of a direct connection made between STEM content and subject knowledge and STEM careers than there was between technology and engineering and STEM careers. Admittedly, instructors did not have strong math and science backgrounds themselves during their K-16 experiences. Campers may benefit from more explicit instruction connecting math and science subjects and content to STEM careers. This has implications for improved and more robust instructor professional development. Instructors would benefit from training in both STEM subjects, content knowledge, and career awareness. In turn, campers would benefit from instructors’ greater awareness and knowledge throughout the camp experience.

In many ways instructor data mirrored the student findings. Both groups came to camp valuing STEM careers and subjects and both were impacted by participating in the camps themselves albeit for slightly different reasons. While students had a genuine interest in the content and saw a correlation between their interests and STEM careers, instructors believed that the exposure to STEM experiences would help female campers believe they were capable and that STEM careers and subjects were a viable option for them to pursue.

It was evident that prior experiences and that STEM experiences in general impacted campers’ interest in STEM subjects and careers. While we cannot be sure what the prior experiences may have been, campers did speak to science experiences they enjoyed as well as knowing others who work in STEM professions. These others were typically a parent. The camp data indicates that the experiences female students had at camp tend to narrow the gap between
the interests of boys and girls in STEM subjects and careers. This may be because boys have had more exposure to STEM and STEM role models that look and see the world as they do. If so, it will be important for female students to continue to have similar opportunities as they progress through the K-12 educational system.

**Interpretation of Findings Through the Lens of SCCT and CRT**

To review, Social Cognitive Career Theory (SCCT) introduced by Lent, Brown, and Hackett (Lent et al., 1994, 2005) is a “useful theoretical lens to understand the mitigating factors that lead to STEM career intent and the unique situation that underrepresented groups are in with respect to their career choice” (Wagstaff, 2014, p. 46). The SCCT framework builds upon Bandura’s (1971, 1986) Social Cognitive Theory (SCT) discussed further in chapter two and has three interrelated models including (a) career interest and awareness, (b) academic and career choice making, and (c) performance and persistence (Lent et al., 1994). The framework helps explain how these three constructs relate to both personal and contextual factors.

When educators ensure they take into account their students’ diversity of experience this is what Gloria Ladson-Billings (1992) coined *culturally relevant teaching* (CRT). Geneva Gay (2010) explains it this way saying that CRT “uses the cultural knowledge, prior experiences, frames of reference, and performance types of ethnically diverse students to make learning more relevant and effective” (2010, p. 3). In chapter two, literature was shared that demonstrated how STEM education and STEM careers have been found to be gender biased toward males in U.S. culture (Blickenstaff, 2005; Chen & Soldner, 2013; Moss-Racusin, Brescoll, & Handelsman, 2012).

For all students to benefit and see relevance, STEM courses and other educational opportunities must first be culturally relevant for all learners in our society. This is a foundational
component for successful STEM education. For this reason we know that traditionally marginalized students benefit if CRT practices are embedded throughout their instructional experiences. As such, the data will be explored through the three models of SCCT along with CRT practices. Therefore, in the discussion below CRT will be embedded within the three SCCT models.

**Career Interest and Awareness**

This first model builds upon Social Cognitive Theory (SCT) and articulates how career interests and awareness develop. The process begins in early childhood as students are exposed to an array of activities which have a potential for career relevance. Young people also observe others perform various occupational tasks (Lent et al., 1994). Ideally, this exposure is varied and differentially reinforced. These experiences, if culturally relevant, have a greater potential to reach students who have been traditionally underrepresented in these fields. “Through repeated activity engagement, modeling, and feedback from important others, including those the student can relate to, children and adolescents refine their skills, and develop personal performance standards, form a sense of efficacy in particular tasks, and acquire certain expectations about the outcomes of their performance” (Lent et al., 1994, p. 89). These experiences lead to initial interests.

During STEM Camp, students had the opportunity to be exposed to both new STEM content and STEM careers. Student-participants also often observed role models performing and demonstrating like tasks. In this study, the majority of camp instructors were female, however, only two camp instructors were people of color. The camp director and assistant director were also female. To ensure underrepresented student groups had an opportunity to observe role models performing STEM tasks, camp planners should strive to ensure instructors are
representative of the student population. In this case, the instructors were representative based on gender, and this may have contributed to the increase in campers’ interest in STEM careers. However, most context and scenarios were pre-developed and from the perspective of camp designers who were white, middle class educators. While campers had choice with regards to some aspects of their projects, many were predeveloped or narrow. This is unlike some of the CRT research reviewed in chapter two in which students had real agency to develop voice and solve problems relevant to their lived experience (see Calabrese Barton & Tan, 2010).

STEM careers were also discussed and introduced during camp sessions. Instructors were observed weaving career discussions into their daily lessons. Camp organizers created PowerPoints which facilitated these discussions. Some instructors felt like they needed more support with making connections between the camp activities and future STEM pursuits. Additional professional development opportunities for instructors to support this interest would be beneficial.

Finally, STEM Camp student-participants had multiple opportunities for, “repeated activity engagement, modeling, and feedback from important others” in order to “refine their skills, and develop personal performance standards, form a sense of efficacy in particular tasks, and acquire certain expectations about the outcomes of their performance.” Each camp session provided for daily opportunities to engage in authentic tasks which incorporated student choice. In this way, the tasks were allowing for cultural variation. Students had the opportunity to focus on tasks and solutions that were relevant to their social and experiential contexts and were supported and encouraged to do so (Gay, 2018; Greer, 2009). However, the depth and authenticity of the task varied from camp to camp. Some sessions included more choice and instructors helped campers by drawing out their interests. Other camp sessions were more task
oriented. While choice and agency were present, the tasks were not always situated in relevant, meaningful contexts and scenarios. The two-week camps seemed to have more authentic, meaningful tasks. This structure may be an important feature for district administrators to consider when designing culturally relevant STEM experiences.

**Career Choice Making**

This model builds upon the former in a developmental way in that it is an extension of interest formation. It has three components. First, there is a selection of a primary career goal; second, are actions which support and help implement the career choice; and third, performance outcomes which provide a feedback loop and influence future career behavior (Bandura, 2004; Lent et al., 1994).

During this study there was evidence of student-participants moving towards a greater interest in STEM careers and subjects. Students became more focused on certain STEM careers from among several and others shared the value of STEM subjects and content for non-STEM careers. Participant interest in all STEM careers (mathematics, engineering, computer science, medicine, and Earth science) increased and maintained six to eight weeks after their STEM Camp experience concluded. There was little to no observable data indicating camp sessions explicitly attempted to connect career discussion and instruction to students’ diverse backgrounds, experiences, or racial identities. Similarly, these careers were not discussed in the context of promoting equity or reducing racial disparities or institutional racism as has been discussed and advocated (see CEOSE, 2017; Gay, 2018; Greer, 2009). Camp sessions could be more culturally relevant if they made connections regarding how STEM careers can be tools for change and power in an unjust society.
Student interest in STEM subjects was positive but uneven. Student interest in science and mathematics improved only slightly over the course of the study. Student interest grew more significantly in the areas of C.S., engineering, and technology. This was not surprising given the focus of the camp was on technology. Significantly, female students new to camp showed the most growth in interest in these STEM careers and subjects, nearly eliminating the gender gap.

Most of the activities and lessons were performance based. In this way, students had the opportunity to get feedback from important others, camp instructors and their peers, about their STEM performance. Students indicated that at camp there was no “right answer,” and a constructivist, inquiry approach, may have contributed to their positive feelings about STEM subjects and careers. Camp administrators could build upon initial participant interest in STEM subjects and careers by building in more connects to secondary and post-secondary STEM career opportunities. They could also improve camp sessions with the inclusion of more diverse cultural referents into the curriculum so that all campers had opportunities to imagine themselves in the STEM professions. It may also be valuable to have students reflect on their interests in writing over the course of their camp experience and provide an opportunity for them to share that with fellow campers and their parents. At this stage, the goal for these young campers is to expose them to more potential STEM career possibilities and give them an opportunity to see these careers as potential options for them in the future.

**Model of Performance and Persistence**

This model includes both performance outcomes and persistence over time (Lent et al., 1994). In line with Bandura’s (1986) theory, the author’s contend that, “self-efficacy asserts a direct effect on performance” (Lent et al., 1994, p. 98). It is helpful to think of performance goals as intermediary goals and akin to goal setting. While this part of SCCT is less in line with design
of this study, there was some relevant data for this third model. Many camp sessions were designed to support students in developing a project and refining it over the course of the week. This was especially true for our two-week camps. Students had opportunities to set project goals and then strive to reach those goals with feedback and guidance from instructors and fellow campers along the way. This is in alignment with CRT practices as it allows students to develop effort optimism and move from a dependent to an independent learner (see Gay, 2018; Hammond, 2014). Explicit goal setting did not appear to be a part of students’ science journals or instructor mini-lessons. Camp administrators could strengthen this aspect of the camp by encouraging goal setting and discussing shorter-term goals that relate to the longer-term goal. For example, students who were interested in a specific career to set goals related to STEM subjects and courses they may want to pursue in middle and high school. These goals could be made more relevant by including familial goals and discussing two-year and technical STEM occupations represented throughout the community.

Summary

SCCT states that people must interact, engage, and be exposed to activities or experience in order to develop an interest in them. “As it relates to career choice, this model suggests that young people choose a career over a period of time where they engage in specific career related activities, are able to see themselves in that career, and then begin to make plans to pursue it” (Wagstaff, 2014, p. 38). Summer STEM Camps, such as the camp under study, do provide opportunities for young people to have the type of experiences described here. However, the literature indicates students need these opportunities over time. It is unclear if a one- to four-week experience would be enough to encourage more female students to pursue STEM coursework in middle and high school or STEM careers in technical and post-secondary schools.
CRT could be strengthened in these camps by increasing the use of students’ prior experiences and backgrounds. For example, the use of interest inventories may support this opportunity and improve camp instructors’ ability to relate course content to students’ interest and prior background knowledge. Also, it is important that camp instructors are representative of the student population. Camp administrators must ensure there is a diverse representation of camp instructors based on race, gender, and age.

**Relationship to Previous Research**

One theme in this study, inquiry-based instruction, was prominently represented in the literature. In this study, students discussed their preference for hands-on, inquiry-based instruction and instructors discussed the contrast of the more constructivist, inquiry-driven instruction during camp to a more traditional lecture focused format during the school year. The literature discussed the fact that major professional organizations and other researchers have called for both more instruction in science and STEM as well as a focus on inquiry-based instruction (Honey, Pearson, & Schweingruber, 2014; Kelley & Knowles, 2016; Kelley, 2012; Miller, 2015). Interestingly, another category within this theme was students’ interest in building and creating. This seems to align to the design of the NGSS. These standards emphasized engineering K-12 for the first time in the U.S. (Pruitt, 2014). In addition, Gay (2010) and others emphasized this strategy as important to meaning-making and relevancy. Hughes (2001) found that when science classrooms had a constructivist approach including student-led investigations, opportunities arose for the reconfiguration of dominant discourses and made room for more ‘hybrid identities.’ Given that STEM instruction and subjects are often positioned as male-gendered (Nasir & Vakil, 2017) these strategies could be employed by schools to help
traditionally underrepresented students better relate to and see the relevance of STEM to their lives and goals.

In relation to Culturally Relevant Pedagogy (CRP), there were two intersections within the findings and the literature. First, students discussed the fact that they felt welcomed and that camp was a positive place (Freire, 1970). In particular, they discussed the social aspects of camp, including developing friends with peers and enjoying their camp counselors. As was noted, many of the camp counselors were female which may have contributed to these feelings. This contrasts with much of the research indicating that STEM environments are gendered in the masculine direction (Wajcman, 2004). For example, Nasir and Vakil (2017) saw similar results in what they called “gendered cultures” and found “that the culture of STEM itself and spaces in which STEM opportunities are made available often reflect the values, interest, and experiences of the dominant culture and as a result are often unwelcoming” to women and other minority groups (p. 377). Second, the student-participants discussed their ability to choose both the camps themselves as well as having choice with projects and activities throughout camp. These findings were categorized into the theme of agency in this study. When students have agency, or the ability to pursue their interests and passions based on their prior experiences this supports a culturally relevant experience for campers (Aoki, 1993; Gay, 2010; Greenwood, 2009; Lefebvre, 1991). Camps and clubs could improve by building in additional ways to get to know campers and recruiting more camp counselors of color.

Other studies have also found gaps in interest and confidence in STEM subjects and careers between males and females. In this study, initial survey data taken before the camp experience showed these gaps, particularly for students who had never attended camp before. Similarly, in another study of middle school youth in three cities spanning a wide range of SES
and ethnic demographics, Shapiro et al. (2015) found using a survey that both boys and girls indicated girls were less interested in STEM careers by sixth and seventh grade. Only 12.4% of girls chose a future career in STEM. However, girls who participated in a single-sex leadership opportunity were less likely than boys and non-participating girls to agree that boys have more career opportunities than girls and said that you can do anything if you work hard at it. Finally, at the conclusion of the experience, participating girls were a third more likely than non-participating girls to choose a STEM career (Shapiro et al., 2015). These findings align to those found in this study.

Lastly, the literature regarding self-efficacy and SCCT discussed at length the importance of performance accomplishments, vicarious experiences (observing others), and verbal persuasion (Bandura, 1977; Velthuis, Fisser, and Peiters, 2015). Observations and interviews data indicated that students in camps had multiple opportunities to perform, or practice STEM activities and strategies central to the goal of the camp, often multiple times each day. In addition, camp instructors served as role models demonstrating and showing mastery. The fact that many of the camp instructors were females supported the female campers’ ability to have vicarious experiences and verbal persuasion. Camp instructors shared during interviews, and it was observed during lessons, that they encouraged student-participants not only to persevere throughout a task, but to pursue STEM opportunities in the future. These opportunities were consistent with what the literature indicates are necessary components for building self-efficacy and career interest (Lent et al., 1994, 2005; Velthuis, Fisser, and Peiters, 2015).

**Limitations and Future Research**

Most research attempting to answer the programmatic impacts of STEM initiatives focuses at middle or high school level (NSTC, 2011; 2013; NRC, 2013). We know that students
start making decisions related to their future and how they see themselves in relation to STEM domains and various career clusters much earlier (Linver, Davis-Kean, & Eccles, 2002; Weisgram, Bigler & Liben, 2010). More research studying the impacts of STEM efforts during and after the traditional school day at the elementary level is needed.

More studies must also include a longitudinal methodology. Current research has primarily measured student interest and self-efficacy as it relates to STEM, post intervention (Miller, 2015; NRC, 2011, 2013). Few answer the question, do quality elementary interventions have lasting impacts which will result in more students, particularly those currently underrepresented, pursuing STEM degrees and entering STEM careers? Do impacts at the elementary level fade or persist over time? Studies following students over time will help answer these questions. This study attempted to measure if the impacts of the camp maintained six to eight weeks after the conclusion of the camp. Further studies over longer periods of time are needed to better understand and refine strategies designed to decrease gaps in STEM interest and participation.

These studies must also have clear goals and aims which are defined and measured. More studies are needed which include control groups to better understand intervention impacts. This was a limitation of this study. We must clearly identify which high-leverage strategies have the greatest impacts over time so that districts can use their limited resources to best effect. In addition, given limited resources, how early should interventions to reduce and eliminate gender and racial gaps in STEM participation be undertaken? This study shows promise that early interventions may be productive and lasting.

Further study must be undertaken exploring which interventions support and maintain STEM interest for girls who have already indicated a curiosity for STEM and participated in
STEM opportunities. In this study, such students showed only modest growth in their interest in STEM subjects and careers when compared to boys and girls new to STEM camp. More information is needed to tailor experiences for this sub-population.

Similarly, we must uncover which supports and professional development strategies best equip new and veteran teachers to effectively teach and catch the imagination of students with regards to STEM education. This study showed promising indications that staff teaching at STEM camps views were positively impacted and that these views influenced how they approached teaching math, science, and technology during the school year. We need more information regarding these possible changes in perception and practice and how they might impact student learning.

Finally, more studies are needed that examine the nexus of STEM, women, and women of color at the K-12 level. As the National Academy of Sciences point out, “few studies seriously consider race or class as central analytic lenses, even if the students involved were of different races and ethnicities” (National Research Council, 2014, p. 142). A limitation of this study was the number of students of color participating at the research site. As has been discussed, there is a great need in our country for additional STEM workers and yet women and women of color, while capable and often prepared, are not choosing to pursue most STEM degrees or careers. There are examples of success at the university level of dramatically reducing gender gaps (Corbett & Hill, 2014). We need to better understand how to better reach and serve women and women of color in the K-12 system.

**Significance and Implications**

Findings from this study should be considered by district officials and camp leaders wishing to improve STEM outcomes for school-aged students via interventions occurring during
and after school as well as during more intensive STEM camps. This study added to the literature indicating that STEM camps and clubs improve students’ interest and awareness of STEM subjects and careers while not necessarily increasing STEM content knowledge. This study added to the literature through the use of a mix-methods design measuring students’ views and perceptions of STEM subjects and careers over an eight- to ten-week period. Students’ views and perceptions largely maintained, and in some cases, increased from the six- to eight-week period of time when camp ended, and when the post-camp survey was administered.

One of the most promising findings from this study was that students new to camp had the largest gains on the survey regarding STEM subjects and careers when compared with camp participants who indicated they had attended a STEM camp previously. This is also a challenge, as veteran campers were more resistant to further increases in positive attitudes for STEM subjects and careers. However, they started camp with higher positive views. Camp designers may wish to explore more advanced opportunities for these campers including leadership opportunities and other suggestions described above such as goal setting and reflection. In addition, camp designers would be wise to offer scholarships and other avenues for new campers to attend camp. It was evident in this study that several campers would not have attended camp had they not been encouraged to do so through an offer to attend free of charge.

Also promising, these preadolescent female participants showed interest and desire to pursue and better understand STEM subjects and careers. These interests increased and became more nuanced over the course of the camp. District administrators would be wise to build upon these experiences by embedding STEM opportunities into the school day.

Finally, the STEM camp seemed to narrow existing gaps found between genders. On the pre-camp survey boys’ views were more positive relative to female campers regarding both
STEM subjects and careers. By the conclusion of the camp, and six to eight weeks later, findings indicated that these gaps for campers new to camp were largely eliminated. This is a significant finding given the current gaps in female participation in STEM degrees and careers. In future studies, it would be important to learn why these gaps existed at such a young age. It would also be important to determine if these changes in view maintain into middle and high school and beyond.

Summary

To ensure all students leave K-12 prepared to pursue STEM opportunities school and community leaders must work together to overcome the challenges discussed here. We must help all girls see the relevance of STEM. We must break down stereotypes about STEM so they can see that STEM careers do align with their goals and self-identity. We must provide young students the opportunity to learn science in ways that are engaging and relevant starting in kindergarten. We must better involve parents and support teachers in the STEM education of their students. Our very economic competitiveness depends upon our success. As Obama pointed out during a White House sponsored science event addressing our shortage of women in STEM fields, “half our team, were not even putting on the field. We’ve got to change those numbers” (Corbett & Hill, 2014, p. ix). We can and must do better.
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APPENDIX
APPENDIX A

Women and Computer Science

Source: National Science Foundation, American Bar Association, American Association of Medical Colleges
Credit: QuocTrung Bui/NPR
APPENDIX B

Interview Protocol: Students

WASHINGTON STATE UNIVERSITY
Educational Leadership and Counseling Psychology
College of Education

Research Study Questions:

1. What are the views perceptions about STEM subjects and careers held by female preadolescent students at the fourth, and fifth grade levels?

2. How might preadolescent students’ attitudes and perceptions change regarding career aspirations and interest in STEM subjects, courses, and clubs?

Study Title: How students’ STEM experiences effect their interest in STEM subjects and careers

Researcher: Matthew J. Henshaw, M.Ed., Director of Elementary Curriculum and Instruction, Teaching and Learning, Spokane Public Schools

Student Protocol

1. Please tell me about yourself and what you like to do outside of school?

2. Why do you come (go) to STEM Camp?

3. When I say the word “science,” what feelings or emotions come to mind?

4. Tell me about what is like to learn science at your school?

5. If someone asked you to explain why it is important that you learn about science, what would you say? How about math? Why is it important to learn about math?

6. Have you heard about engineering? How do you feel about engineering?

7. Do you enjoy using computers and technology to learn or create things? Why or why not?

8. What goals do you have for your future when you grow up? What do you want to do? Does it involve science and engineering? Do you think more involvement in STEM Camp will help you feel more open/comfortable with the idea of working in a STEM job?

Additional questions: post-camp experiences (not asked first round)
9. How would you describe STEM Camp to another student?

10. How do/did you feel when you are at STEM Camp?

11. Tell me a story about the best experience you had at camp? What did you make or do and why was it the best experience?

12. How is camp different from how you learn science or technology at school during the year?

13. How would you change STEM camp?

14. Did you feel welcome at STEM Camp? Like you belong?
APPENDIX C

Interview Protocol: Instructor

WASHINGTON STATE UNIVERSITY
Educational Leadership and Counseling Psychology
College of Education

Research Study Questions:

1. What are the views perceptions about STEM subjects and careers held by female preadolescent students at the fourth, and fifth grade levels?

2. How might preadolescent students’ attitudes and perceptions change regarding career aspirations and interest in STEM subjects, courses, and clubs?

Study Title: How students’ STEM experiences effect their interest in STEM subjects and careers

Researcher: Matthew J. Henshaw, M.Ed., Director of Elementary Curriculum and Instruction, Teaching and Learning, Spokane Public Schools

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Director and Camp Instructor Protocol

1. Please briefly tell me your education history including any undergraduate (or graduate) science coursework and science professional development you have participated in.

2. Briefly tell me your professional work history and experience including subjects and grade levels taught.

3. Why do you work at the summer STEM Camp?

4. How is STEM camp different from teaching science, math, engineering and technology as a classroom teacher?

5. Do you feel that female students benefit from attending the camp? How?

6. How do you feel female students are impacted, or change their perspectives, by attending a STEM camp?

7. If you had a daughter this age, would you bring your daughter to STEM Camp? Why?

8. If someone asked you to explain why it is important that you teach STEM at the elementary level what would you say?

9. Describe how confident you feel in teaching science to your students and what makes you feel this way?

10. Has working at the STEM camp changed how you feel about science, technology, engineering, or math? Why?
APPENDIX D

Upper Elementary Student Attitudes toward STEM Survey (S-STEM)
**Student STEM Survey**

**Camper:** This survey is about students’ interest in STEM careers and classes. Taking part if this survey will help us make the STEM Camp and our after-school clubs even better for you and other students in our district. You can ask questions anytime. If there is any question you do not want to answer, that is okay, you can skip it and you can stop at any time.

Grade Level Next Year (Choose 1):

___ 4th Grade

___ 5th Grade

___ 6th Grade

___ Other

Gender:

___ Male

___ Female

This is my first time at a STEM Camp ___ Yes ___ No

**Directions:**

There are lists of statements on the following pages. Please mark your answer sheets by marking how you feel about each statement. For example:

<table>
<thead>
<tr>
<th>Example 1:</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like engineering.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

As you read the sentence, you will know whether you agree or disagree. Fill in the circle that describes how much you agree or disagree.

Even though some statements are very similar, please answer each statement. This is not timed; work fast, but carefully.

There are no "right" or "wrong" answers! The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.

Please fill in on only one answer per question.
### Math

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Math has been my worst subject.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. I would consider choosing a job that uses math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. Math is hard for me.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4. I am the type of student to do well in math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>5. I am good at math</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>6. I am sure I could do advanced work in math.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

### Science

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. I am sure of myself when I do science.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>8. I would consider a job in science.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>9. I expect to use science when I get out of school.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>10. Science will help me earn money.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>11. I will need science for my future work or job.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>12. I know I can do well in science.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Engineering and Technology**

Please read this paragraph before you answer the questions.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. I like to imagine creating new things (toys, tools, or products).</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>14. If I learn engineering, then I can improve things that people use every day.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>15. I am good at building and fixing things.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>16. I am interested in what makes machines work.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>17. Designing products or buildings will be important for my future job.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>18. I am curious about how electronics/technology work.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>19. I would like to use creativity and invent new things in my job one day.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
**Your Future**

Here are descriptions of subject areas that involve math, science, engineering and/or technology, and lists of jobs connected to each subject area. As you read the list below, you will know how interested you are in the subject and the jobs. Fill in the circle that relates to how interested you are. There are no “right” or “wrong” answers. The only correct responses are those that are true for you.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Not at all Interested</th>
<th>Not So Interested</th>
<th>Interested</th>
<th>Very Interested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medicine:</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>People learn how the human body works. They decide why someone is sick or hurt and give medicines to help the person get better. They teach people about health, and sometimes they perform surgery.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Engineering:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People use science, math and computers to build different products (everything from airplanes to toothbrushes). Engineers make new products and keep them working.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Computer Science:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People write instructions to run a program that a computer can follow. They design computer games and other programs. They also fix and improve computers for other people.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Earth Science:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People work with the air, water, rocks and soil. Some tell us if there is pollution and how to make the earth safer and cleaner. Other earth scientists forecast the weather.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Mathematics:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People use math and computers to solve problems. They use it to make decisions in businesses and government. They use numbers to understand why different things happen, like why some people are healthier than others.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E

STEM Camp Brochure

Choose Your Camp

ROBOTICS AND ENGINEERING

LEGO ROBOTICS: FORCE AND MOTION | Grades K-3
This camp is recommended for kids who have little experience with building and simple programming. LEGO Robotics: Force and Motion introduces students to basic robotics and programming to solve unique problems.

LEGO ROBOTICS: MOTORS, SENSORS, AND PROGRAMMING | Grades K-3
Kids who have experienced Simple Machines and LEGO make their own robots and learn basic robotics and programming to solve unique problems.

LEGO ROBOTICS: MINDSTORMS | Grades K-3
Students build and program LEGO Mindstorms robots to compete in FIRST LEGO competition. Students will build a robot and be challenged to solve a mission end-end unique problems.

GRILLO LEGO | Grades K-4
LEGOs are a great start to learning about engineering, coding, and the scientific process. Our LEGO camps are filled up to kids 6 years of age. There will be a camp for boys and a for girls. Intended for children interested in building and robotics. This camp is specially designed for girls interested in STEM and will encourage them to follow their dreams and embark on a STEM career.

COMPUTER DESIGN AND PROGRAMMING

MAKE MY GAME | Grades K-8
Kids will use Scratch and MIT App Inventor to learn basic block programming, then give them the challenge to design and program their own games to solve unique problems.

CODECAMP | Grades 3-8
This camp is recommended for kids who have experience with the Make My Game camp. Campers will learn the basics of robotic programming language to create own games.

RASPBERRY PI: BUILD YOUR FIRST COMPUTER | Grades 5-12 (Weeks 1, 2)
Participants will learn about computer software and hardware, and build their own Raspberry Pi computer.

3D DESIGN AND PRINTING | Grades 5-8
Participants will learn about computer software and hardware, and build their own Raspberry Pi computer.

FLYING IDEAS: CIRCUITRY | Grades 4-8
Students will learn about computer software and hardware, and build their own Raspberry Pi computer.

LED NATION: LIGHTS, POWER, PROGRAMMING

SUBWAY CIRCUITS | Grades K-3
This camp is recommended for kids who have little experience with electrical circuits. Campers will learn to control and modify LED lights by creating simple circuits.

WEARABLES | Grades 4-8
This camp is recommended for kids who have experience with electrical circuits. Campers will learn to control and modify LED lights by creating simple circuits.

FLASH! SAYS SCIENCE: Grades 4-8
This camp is designed for kids who have experience with electrical circuits. Campers will learn to control and modify LED lights by creating simple circuits.

2018 Summer STEM & Arts Camps

Spokane Public Schools Summer STEM (Science, Technology, Engineering, and Math) & Arts Camps provide activities, experiments, projects, and field experiences. These camps offer hands-on, problem-solving, critical thinking, communications, and leadership skills through fun, engaging activities. Camp research confirms that these camps improve students' critical thinking, communication, and leadership skills.

Weeks available:
Week 1: July 16-21 | Week 2: July 30 - Aug 4
Week 3: July 7-12 | Week 4: July 24-28

Camp Fees:
$80/week | 2-Week Camps $160
USD Breakfast and Lunch Program offered at camp. Breakfast begins at 8 a.m. Camps officially start at 8:30 a.m.

Monday – Thursday | 8 a.m. to 1 p.m.

Locations
Chase Middle School | 6717 E. 37th Ave.
Salk Middle School | 6611 N. Alberta St.

LIGHTS, CAMERA, ACTION

VIDEO CONSTRUCTION: BEGINNER AND ADVANCED | Grades 5-8

STOP-MOTION ANIMATION: BEGINNER AND ADVANCED | Grades 5-8

STORY-TELLING ANIMATION: BEGINNER AND ADVANCED | Grades 5-8

STEAM ART STUDIOS

KIDS LOVE...

KIDS LOVE CHEMISTRY | Grades K-6

KIDS LOVE ENGINEERING AND CONSTRUCTION | Grades K-6

KIDS LOVE ROCKETRY AND JETPACKS | Grades K-6

KIDS LOVE BIOMEDICAL SCIENCE | Grades K-6

KIDS LOVE WEARABLES | Grades K-6

AND EVEN MORE!

CAMP COMING SOON: Grades 5-9-week Week 5

YOUNG ROCKET DRIVERS | Grades 5-8-Week

STEM AfterSchool and Summer Programs

509.354.4648 or register online @ www.spokanekshools.org/summersSTEMcamps
Greetings, Families!

We are excited to announce a convenient new way to register online for Summer STEM & Arts Camps. FamilyID is a secure registration platform that provides an easy, user-friendly way to sign up for camp, and helps us to be more administratively efficient and environmentally responsible.

When you register through FamilyID, the system keeps track of your information in your FamilyID profile. You enter your information only once for each family member for multiple uses and multiple programs.

REGISTRATION PROCESS
1. Visit www.spokaneschools.org/summerstemcamps and click on the Register button.
2. Next, click on the Family ID button for the camp you want your child to attend. If this is your first time using FamilyID, click Create Account. If you already have a FamilyID account, click Log In.
3. Create your secure FamilyID account by entering the account owner's First and Last names, Parent/Guardian, email address, and password. Select I Agree to the FamilyID Terms of Service. Click Create Account.
4. You will receive an email with a link to activate your new account. (If you don't see the email, check your email filters (spam, junk, etc.)
5. Click on the link in your activation email, which will log you in to FamilyID.com.
6. Once in the registration form, complete the information requested. All fields with a red * are required to have an answer.
7. Click the Save & Continue button when your form is complete.
8. Review your registration summary.
9. Click the green Submit button. After selecting Submit, the registration will be complete. You will receive a complete email from FamilyID confirming your registration.

SUPPORT:
- If you need assistance with registration, contact FamilyID at support@familyid.com or 888-805-5983 x1.
- Support is available 7 days per week and messages will be returned promptly.

THERE ARE THREE WAYS TO PAY FOR CAMP:
- Pay through My School Buys at the completion of your registration.
- Bring your confirmation to the cashier's office at 200 N. Boardwalk St. (Cash, check, or money order)
- Mail your check or money order to SPS Central Cashier, 200 N. Boardwalk St., Spokane, WA 99201. Please put your child's name in the notes area on the check or money order.

Registrations are not complete until full payment has been submitted.

www.spokaneschools.org/summerSTEMcamps