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A STUDY OF UNDERREPRESENTED MINORITIES IN AN INFORMAL STEM EXPERIENCE

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A STUDY OF UNDERREPRESENTED MINORITIES IN AN INFORMAL STEM EXPERIENCE

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Education at the University of Kentucky

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ABSTRACT OF DISSERTATION

A STUDY OF UNDERREPRESENTED MINORITIES IN AN INFORMAL STEM EXPERIENCE

According to labor market data, there is core cognitive knowledge, skills, and abilities associated with STEM education that are in demand in not just STEM fields, but all areas of the workforce (Carnevale, Smith, & Melton, 2011; Rothwell, 2013). During the period from 2005 until 2015, STEM professions grew by 24.4% (Noonan, 2017). During this time, populations such as minorities continued to show a gap in their representation in STEM (Noonan, 2017). To effectively examine how to increase the rate of URM student success in STEM, more research is needed on the factors that might contribute to minority STEM interest, self-efficacy, and increase in career interests (Teitjen-Smith, Masters, & Smith 2009). This study aims to determine how underrepresented populations having access to an informal STEM learning experience impacts interest, self-efficacy, and career intentions in STEM using Social Cognitive Career Theory (SCCT). Through a case study design, the experiences of underrepresented adolescents who participated in a 2018 summer STEM robotics camp were examined through structured interviews. What follows represents a qualitative analysis of themes regarding how informal STEM learning experiences can impact underrepresented participants' STEM interest, STEM self-efficacy, and STEM career interest.

KEYWORDS: STEM Education, Informal STEM Experiences, Social Cognitive Career Theory, Case Study, Underrepresented Minorities

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DEDICATION

To Grace Rose. Keep Going.

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CHAPTER 1. INTRODUCTION

1.1 Introduction

According to labor market data, there is core cognitive knowledge, skills, and abilities associated with STEM education that are in demand in not just STEM fields, but all areas of the workforce (Carnevale, Smith, & Melton, 2011; Rothwell, 2013). In the world we now live, there is the need to solve complex problems by gathering, evaluating and making sense of information. The knowledge, skills and abilities associated with STEM will prepare our students for a world where it is more valuable to understand how to use knowledge, rather than the knowledge itself. During the period from 2005 until 2015, STEM professions grew 24.4% (Noonan, 2017). During this time, populations such as women and minorities continued to show a gap in their representation in STEM (Noonan, 2017). The President's Council of Advisors on Science and Technology stressed the importance of all Americans especially underrepresented populations to fill the STEM pipeline (Holdren & Lander, 2012). An increase in these underrepresented groups can diversify our STEM workforce to increase innovation and drive solution-making (Hill et al., 2010). STEM education for all students has become the key piece to increase the knowledge, skills and ability needed to increase interest to diversify our STEM workforce. During formative educational years, teachers can be important leaders in inspiring our youth to pursue STEM careers (Kaminsky & Behrend, 2015; Rogers & Creed, 2011).

1.2 Statement of the Problem

The United States is not utilizing its potential resources in the science, technology, engineering and mathematics (STEM) workforce. According to the National Science Foundation (2107), minorities made up 39% of the population in 2014 but represented only 20% of those awarded undergraduate degrees in science and engineering. The same study predicts that by the year 2060, minorities will constitute more than half of the adult population in the United States. Women and minorities are underrepresented in many STEM professions (Corbett & Hill, 2015; Holdren & Lander, 2012; Xue & Larson, 2015). Underrepresented minorities are defined as African Americans, Hispanic and Latinos, and Native Americans (NAS, 2011). In 2014, women and underrepresented minorities consisted of 69% of ages 18 to 64 of the U.S. working population (NSF, 2017). Accessibility and negative stereotypes have been considered barriers to STEM degrees and careers for women and underrepresented minorities (NAS, 2011). Accessibility would be considered exposure to STEM resources (NAS, 2011). This lack of access, along with other contextual factors, is increasing the gap. To reduce the STEM workforce gap, we must learn valuable ways to recruit and retain underserved populations such as women and minorities (Beede et al., 2011; Xue & Larson, 2015). Reducing barriers to STEM in underrepresented populations with targeted informal STEM learning experiences may be one valuable solution to a STEM-ready workforce in the future.

1.3 Purpose of the Study

The federal government identified STEM as needed areas for the nation to remain globally competitive (Shapiro & Sax, 2011). Compared to their workforce numbers, women and other underrepresented minorities do not have a proportional presence in the STEM fields (Corbett & Hill, 2015; U.S. Department of Education, NCES, & IPEDS, 2016; NSF, 2017). Because of the underrepresentation of certain populations in the STEM workforce, more research needs to be conducted to determine what STEM interventions can work with the current approaches to open up the STEM pipeline to the underrepresented. This study proposes to use data from an informal learning experience to further the research regarding underrepresented student populations and what impacts their interest, self-efficacy, and career intentions.

1.4 Research Question

This study aims to answer the following question:

How does an informal STEM learning experience impact underrepresented minority students' STEM interest, STEM self-efficacy, and STEM career goals?

1.5 Significance of Study

Social Cognitive Career Theory (SCCT) has been the conceptual framework for a considerable amount of research involving self-efficacy and interest (Lent, Brown & Hackett, 1994). A significant amount of the research has used SCCT to assess changes in self-efficacy and interest in learning experiences for students. At the point when students have high self-efficacy and positive outcome expectations, they tend to develop interest in an activity, and subsequent goals that increases involvement in the activity (Brown & Lent, 2013).

This study aims to determine how underrepresented populations having access to an informal STEM learning experience impacts interest, self-efficacy, and career intentions in STEM. This study will contribute to a body of research surrounding student self-efficacy, interest, career intentions, and outcome expectations in the area of STEM education. As we learn more about how to increase these constructs for underrepresented students, we will begin to increase the number of underrepresented minorities in our STEM workforce.

1.6 Conceptual Framework: Social Cognitive Career Theory

The conceptual framework that will guide this study is Social Cognitive Career Theory (SCCT). This theory focuses on the development and influences of occupational choice (Brown & Lent, 2013). Social Cognitive Career Theory helps to explain how one develops occupational interests to make career choices (Lent, Brown, & Hackett, 2002; Brown & Lent, 2013). This study will use this theory as a basis for understanding occupational and educational behavior by looking at the variables that affect career development: self-efficacy beliefs, outcome expectations, and personal goals (Brown & Lent, 2013). Self-efficacy can be defined as the belief that one can produce the desired outcome, while outcome expectancy is the expectation that particular behaviors will produce these desirable outcomes (Lent, Brown, & Hackett, 1994). Personal goals are part of a person's intention involved in an activity and career development (Brown & Lent, 2013; Olson, 2014). According to SCCT, one's beliefs about themselves are a strong determining factor of career interest, pursuit and the career realization. If one does not believe he or she can succeed in one path, then the low self-efficacy will drive the development of career interests, goals, and actions to another path. And if one does believe he or she can succeed on that path, then high self-efficacy will continue to drive the development of those same career interests, goals, and actions on the existing path. Research has shown that performance accomplishments have a great impact on self-efficacy (Brown & Lent, 2013), meaning if one believes that they cannot accomplish something, they will not even attempt it (Bandura, 1977). As stated previously, outcome expectancy is the expectation that particular behaviors will produce these desirable outcomes (Lent, Brown, & Hackett, 1994), and can greatly affect a person's career decisions (Olson, 2014). SCCT postulates that career choice is dynamic and is done through social experiences. Because of this, interventions such as informal learning experiences in the form of STEM camps can influence self-efficacy, and alter expectation outcomes, ultimately influencing career choice.

An informal summer camp can provide students with a hands-on, authentic learning experience. Students attending the camp can work together to overcome barriers and find solutions. When a student can develop high self-efficacy and positive outcome expectations, the student will persist to overcome barriers, and be more likely to have a career in that field (Bandura, 1977; Brown & Lent, 2013). These types of authentic learning experiences might lead to a greater interest, higher self-efficacy and positive outcomes in the areas of STEM. Because of this, informal STEM experiences can lead to an increase in STEM academic and career decision-making.

SCCT has been used to study student interest and pursuit of STEM fields (e.g., Chakraverty & Tai, 2013; Soldner, Rowan-Kenyon, & Inkelas, 2012). In addition to these studies, SCCT has been used to study underrepresented students (e.g., da Silva Cardoso, Dutta & Chiu, 2013; Deemer, Thoman, & Chase, 2014; Lent, Miller, & Smith, 2013; Garriott, Flores, & Martens, 2013). According to the SCCT model, self-efficacy and outcome expectations are influenced by personal inputs, background environmental factors, and learning experiences. This means that personal input such as gender, race/ethnicity, and disability may offer advantages or disadvantages in a given context. Lent and Brown (1996) have noted that students may eliminate some career options prematurely based on preexisting beliefs. See Blue STEM Camp can function as a powerful contextual factor according to the SCCT model and can thereby influence career choice behavior among its participants. Thus, underrepresented students may experience a transformation in career intentions. In these instances, the See Blue STEM Camp experience can help to build self-efficacy and confidence and expose additional career possibilities.

1.7 Relevant Terminology

1.7.1 STEM

STEM is an acronym for science, technology, engineering, and mathematics education (Blackley & Howell, 2015).

1.7.2 URM

URM is an acronym for underrepresented minorities. The term is used to describe the disproportionate lack of African American, Hispanic, American Indian, and Alaskan Natives participating in STEM education as compared to Caucasian and Asian students (Estrada et al., 2016).

1.7.3 Social Cognitive Career Theory (SCCT)

Lent et al. (2005) defined SCCT as the interplay between the person, environment, and behavioral variables that directly affect career interest, choices, and performance.

1.7.4 STEM Interest

STEM interest is finding a fascination or value in STEM.

1.7.5 STEM Self-efficacy

STEM self-efficacy is the confidence in an individual's ability to complete relevant STEM tasks (Hardin & Longburst, 2015).

1.7.6 Informal Learning Experience

"Lifelong learning in science, technology, engineering, and math (STEM) that takes place across a multitude of designed settings and experiences outside of the formal classroom" (Center for Advancement of Informal Science Education, 2017).

1.7.7 STEM Career Goal

A person's intentions to engage in a particular activity such as seeking a major or career as a personal goal (Lent et al., 1994).

1.8 Assumption

It is assumed that students who were interviewed answered the questions to the best of their ability and were honest about their answers. It is possible that students responded dishonestly or neglected to fully disclose all detailed information. The research assumes parents filled out the registration form with correct information.

1.9 Limitations

The interview questions were created and chosen by program leadership. The interviews were conducted by staff and summer program leadership. The audio recordings were transcribed by those staff and program leadership attending the summer camp.

1.10 Delimitations

Not all students who wanted to attend camp were able to attend due to challenges and barriers they faced (e.g., transportation needs). In addition, this study was limited to geographic region – where a student could feasibly travel.

1.11 Organization of Dissertation

The purpose of this study is to determine the impact on underrepresented populations' interest, self-efficacy, and career intentions through an informal STEM learning experience.

Chapter I includes an introduction to examine the research problem and purpose, presents the research questions, explores the significance of the study, explains the Social Cognitive Career Theory as a conceptual framework, provides definition of terms, and finally includes the assumption and delimitations.

Chapter II consists of a literature review of studies related to SCCT as a conceptual framework, a review of URM in STEM informal experiences, and a foundation for understanding STEM interest and STEM self-efficacy in learning environments and experiences.

Presented in Chapter III is a research design and methodology including a description of the data used, the participants, and research questions. The chapter also includes the data collection process, data analysis, and study limitations.

Chapter IV includes analysis of data, findings, and summary of results.

Chapter V consists of conclusions, study concerns, and recommendations for future studies.

1.12 Chapter Summary

An increase in underrepresented populations can diversify the STEM workforce to increase innovation and drive solution-making (Hill et al., 2010). During formative educational years, teachers can be important leaders in inspiring our youth to pursue STEM careers (Kaminsky & Behrend, 2015; Rogers & Creed, 2011). According to the National Science Foundation (2107), minorities made up 39 % of the population in 2014, but represented only 20 % of those awarded undergraduate degrees in science and engineering. This study aims to answer the following question: How does an informal STEM learning experience impact underrepresented minority students' STEM interest, STEM self-efficacy, and STEM career goals? Using Social Cognitive Career Theory (SCCT) as conceptual framework, this study will contribute to a body of research surrounding how informal STEM learning experiences can function as a powerful contextual factor to influence career choice behavior among its participants. As we learn more about how to increase these constructs for underrepresented students, we will begin to increase the number of underrepresented minorities in our STEM workforce.

CHAPTER 2. LITERATURE REVIEW

2.1 Underrepresented in STEM

This chapter reviews the literature on relevant studies involving underrepresented minorities (URM) in STEM experiences and environments, and Social Cognitive Career Theory, as a conceptual framework foundation for understanding impact on STEM interest and STEM self-efficacy. The United States has had a well-documented failure to maintain a steady flow of underrepresented minority (URM) students in the STEM academic "pipeline". Issues facing the workplace and lack of qualified workers call for innovations that attract more interest in STEM and increase the availability of professionals (Byars et al., 2010). More than 30 % of those enrolling in STEM degrees do not complete STEM undergraduate degrees (Chen, 2013). Underrepresented populations have experienced academic and social shortfalls that have directly affected their ability to pursue postsecondary opportunities, specifically in STEM fields (Byars-Winston et al., 2010). The ability to increase interest in STEM fields may be impacted by the decrease in retention rates for URM students. In addition to the lack of interest in entering STEM careers for the general population, there are unique challenges posed by the underrepresentation of specific groups in STEM. Ethnic minorities and women are significantly underrepresented in many STEM fields (Cheryan et al., 2017; Hrabowski, 2018). The purpose of the present study is to develop an understanding of how informal STEM experiences impact underrepresented minority students. As there is a high demand to increase the STEM workforce, it is crucial to understand the factors that promote student interest, self-efficacy and career goals among underrepresented populations, including supports and barriers that play a role.

2.2 Gender

Women are highly underrepresented in many STEM sectors (U.S. Bureau of Labor Statistics, 2017). Women 47% of the total US workforce, but only 39% of those employed in chemistry occupation, 27% of those employed in informal science occupation, 26% of those employed in computer and mathematical applications, and 7 to 12% of those employed in civil, mechanical, electrical, and industrial engineering occupations (U.S. Bureau of Labor Statistics, 2017). One theme in the literature on the underrepresentation of women in STEM fields focuses on childhood experiences (Morrell et al., 2004).

2.3 Socioeconomic Status

Regarding STEM career development, socioeconomic status (SES) has been shown to be important (Fouad & Santana, 2017). Student SES is defined as the parental occupation, income, education, and societal rank (Markus & Kiske, 2012). African American students with lower SES are less likely to pursue higher education compared to Caucasian students (Lian, 2017). Higher social class among Mexican America middle school students was found to be a positive predictor of math and science performance accomplishments affecting efficacy and outcome expectations (Navarro et al., 2007). Adolescents from lower socioeconomic status (SES) environments tend to be underrepresented in STEM occupations. Socioeconomic Status has been shown to be an environment that can afford or deny opportunities to adolescents (Diemer & Ali, 2009). Research on SES in the STEM career development context is limited, and further research on SES as a predictor of STEM efficacy and outcome expectation is important, given the underrepresentation of students from lower SES groups in STEM fields (Flores et al., 2017).

On the whole, there is a lack of adequate research showing how multiple barriers relate to adolescents' STEM interest, STEM self-efficacy, and STEM career goals among those from underrepresented groups. Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994, 2002) can be used to conceptualize those factors and the relationships among them.

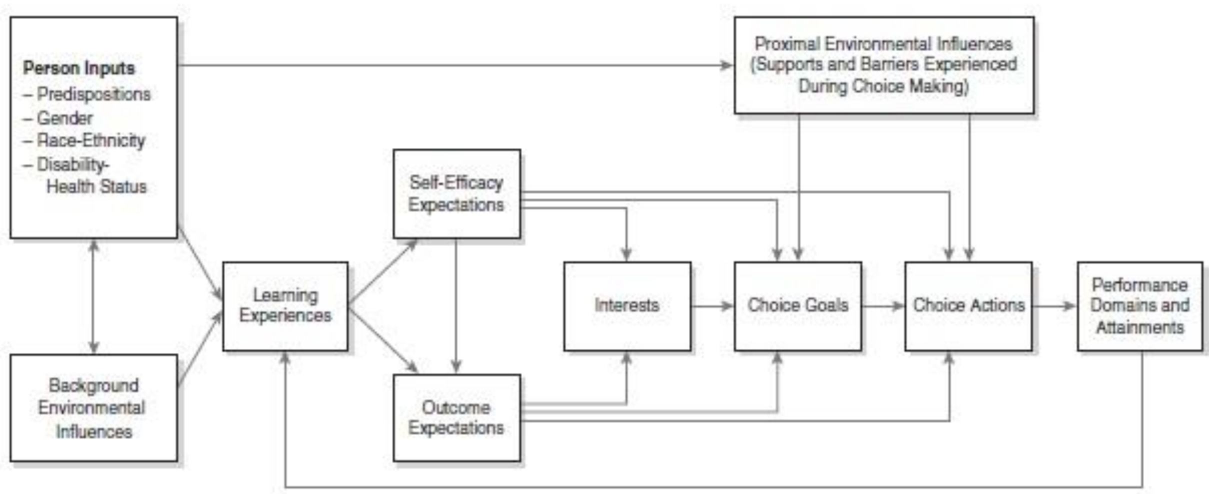
2.4 Race/Ethnicity

Byars-Winston et al. pointed out that individuals must overcome race and ethnicity issues to accomplish academic tasks. A widely known concern is that minority populations are highly underrepresented in STEM fields (Howard et al., 2009; Jayaratne et al., 2003; NSB, 2006; NSF, 2013; Stake & Mares, 2000; Taningco, et al., 2002). It is widely known that URM students have less access to informal learning opportunities compared with majoritarian students (Ware and Lee, 1998; Smith and Walker, 1988; Catsambis, 1994). Underrepresented minority participation in a STEM programs can impact the persistence and career goals. Studies indicate that participation in STEM intervention programs like informal learning experiences can significantly influence persistence among URM students pursuing STEM fields (Jackson and Winfield, 2014). Kendricks et al. (2013) showed the impact of mentoring in a STEM program. Their study found that mentoring had the strongest impact on minority students' performance in STEM. Underrepresented minority student confidence and communication skills can be promoted through STEM programs (Ghee et al., 2016). Ghee et al. (2016) examined parts of a STEM summer program related to persistence and success. The results showed that components increased students' self-efficacy. In contrast, Jayaratne et al.'s study of a summer science program showed that underrepresented minority participants had different outcomes than that of majoritarian students. Majoritarian participants maintained relatively high levels of self-concept of science ability, interest, and science career goals, while minority participants' self-concept and attitudes lowered (2003). There continues to be a lack of research on how components of an informal STEM learning experience impact underrepresented minorities especially in an informal STEM learning experience. Teinda (2013) asks one to consider not only diversifying STEM education, but also inclusifying STEM education, so as not to compromise efforts to promote diversity (Puritty et al., 2017). Part of inclusifying may include determining those aspects of programs (such as informal STEM learning experiences) that are considered successful through the experiences of student participants.

2.5 Social Cognitive Career Theory as a Foundation

Social Cognitive Career Theory (SCCT) seeks to explain three interrelated aspects of career development (Lent et al., 1994). First, SCCT is a framework that determines how academic and career interests develop. Second, one can understand how educational and career choices are made through the SCCT framework. And finally, SCCT aims to help us understand how academic and career success is accomplished. Within this framework, concepts such as interests, abilities, values, and environmental factor are incorporated from Bandura's earlier Social Cognitive Theory (Bandura, 1986).

Figure 2.1, *Social Cognitive Theory Adapted from R. W. Lent, S. D. Brown, and G. Hackett (1994).*



2.5.1 Self-Efficacy

The basic building blocks of Social Cognitive Career Theory are self-efficacy beliefs, outcome expectations, and goals (Lent et al., 1994). Self-efficacy is characterized by an individual's personal beliefs regarding his/her own capabilities in performing a task or to act/behave in a certain fashion (Bandura, 1986). Self-efficacy differs from confidence and self-esteem because it is specific and changeable depending on the task, action, or behavior. One can vary in self-efficacy depending on the occupation or field area. It is possible for persons to have high self-efficacy in one part of a project and low self-efficacy in another part of the same project.

2.5.2 Outcome Expectations

Outcome expectations are the beliefs about the outcomes of performing particular behaviors (Lent et al., 1994). For example, one might look at outcome expectations as potential consequences for a certain chosen action. People may choose to engage in activities because they feel their involvement might be valued, or there could be positive outcomes that might include social and self-approval. This model explains that people make choices about activities based on effort and persistence in the activity including self-efficacy beliefs.

2.5.3 Goals

A person's intentions to engage in a particular activity such as seeking a major or career can be defined as a personal goal (Lent et al., 1994). In order to guide and organize behavior toward a desired destination, one sets goals. These goals are tied to self-efficacy and outcome expectations. In effect, these goals are consistent with their views on their capabilities to accomplish the task, and of the outcomes they expect while attempting to complete the task. One can alter or confirm self-efficacy beliefs and outcome expectations through either failing or success in reaching personal goals.

2.5.4 SCCT Contexts

Social Cognitive Career Theory (SCCT), as a career development theory (Lent, Brown, & Hackett, 1994, 2000; Lent, 2005; Lent et al., 2008) may be used to identify goal persistence for underrepresented populations. As an extension of Bandura's (1986) Social Cognitive Theory, Lent and his colleagues suggest that background learning experiences such as performance accomplishments (successes and failures performing some tasks), vicarious learning (observing others perform a task), social persuasion (related to family and friends), and physiological arousal (emotional states) lead to the development of career self-efficacy. It is also assumed that self-efficacy influences career choices, as behavioral factors interact to impact academic and career interest, goal choice, actions and performance outcomes.

2.5.5 SCCT Studies of Underrepresented

The SCCT framework has been used to study career choice and persistence in STEM for underrepresented populations. These studies' findings have been used to develop interventions for underrepresented students (Byars-Winston et al., 2001; Lent, Sheu, Gloster, & Wilkins, 2010). Present literature is limited in the factors that predict STEM interest, STEM self-efficacy, and STEM career goals in underrepresented populations.

2.5.6 SCCT Framework in STEM

Abilities and capabilities are secondary to an individuals' need for self-efficacy when measuring success in STEM fields (Byare-Winston et al., 2010). According to the SCCT model, an individuals' interest, particularly in STEM, is directly influenced by the confidence in their ability to succeed in accomplishing tasks (Hardin & Longhurst, 2015). The SCCT model also contains factors related to interest in careers that are associated with individuals' self-efficacy or confidence in their ability to complete the relevant STEM tasks (Hardin & Longhurst, 2105). SCCT theory has been used to describe the reasons for interest and choices made in educational fields of study (Hardin & Longhurst, 2015). The SCCT explains factors that affect students' ability to succeed in STEM subjects; these factors can decrease interest in STEM subjects (Hardin & Longburst, 2015). Hardin and Longhurst (2015) examined 184 students using a longitudinal study that assessed academic efficacy at the beginning and end of the semester. Their research highlighted the importance of self-efficacy. Self-efficacy is an important factor that keeps students pursuing STEM tracks of education (Hardin & Longhurst, 2015). In line with the thinking of Bandura, Hardin Longhurst (2015) found that lower self-efficacy was directly correlated to the lower interest in STEM. According to Hardin and Longhurst (2015), lack of interest in STEM is indirectly associated with the learning environment.

Lent et al. (2005) defined Social Cognitive Career Theory (SCCT) as the interplay between the person, environment, and behavioral variables that directly affect career interest, choices, and performance. Lent et al. (2005) examined characteristics of the SCCT theory to determine the STEM interest in male and female students enrolled at two historically Black colleges and universities and one predominantly White university. The characteristics examined and included self-efficacy, outcome expectations, social supports and barriers, interest and choice goals. Nearly all of the 450 first year student participants were enrolled in engineering majors. Eighty-seven percent of the participants were African American, while 33% of the participants were women. The study showed that students who attended the historically Black universities had significantly higher academic self-efficacy, outcome expectations, technical interest, and social support than students attending the predominately White institution. Lent et al. found that the environment in both institutions was key to their overall level of self-efficacy. Students of been shown to relate well to environments that have commonality based on gender or race (Hardin & Longhurst, 2015; Lent et al., 2005).

Finally, Byars-Winston et al. (2010) used the Self-Efficacy Academic Milestones Scale to measure confidence in participants' the ability to complete tasks relevant to STEM majors. Byars-Winston et al. found direct relationships between self-efficacy and outcome expectations. There was little evidence to support the direct association between ethnicity and self-efficacy (Byars-Winston et al., 2010), indicating that as long as the members of the underrepresented populations felt comfortable interacting with ethnic groups outside their own, they were confident about STEM pursuits. Therefore, the higher the efficacy level, the more secure the participants were in their STEM courses.

2.6 Informal STEM Learning Experiences

Informal learning is everywhere, and never ending, happening all the time as we encounter experience (Golding, 2011). There is a close relationship between formal and informal learning, but a distinction can be drawn. Hager & Halliday (2007) have described the difference as those occasions where people learning without the intentional mode of education. Malcolm et al. ((2003) cautioned against distinguishing different kinds of learning such as formal and informal into separate categories. These are not discrete categories and the lines are often blurred as they merge in certain instances. Malcolm et al. suggested that formal and informal be perceived as attributes in all circumstances of learning based on relationships, and effects on learners, teachers and environment.

Informal STEM learning experiences can be defined as “lifelong learning in science, technology, engineering, and math (STEM) that takes place across a multitude of designed settings and experiences outside of the formal classroom” (Center for Advancement of Informal Science Education, 2017). Informal learning environments can be categorized into three major settings: everyday experiences, designed settings, and programmed settings (Kotys-Schwartz, Bester-field-Sacre, & Shuman, 2011).

Students in traditional classroom settings will get exposure to STEM topics during their K-12 education, but according to research, there are additional benefits to

STEM informal learning experiences (Ayar, 2015; Denson et al., 2015; Schnittka et al., 2012; Weber, 2011). Informal learning environments can provide context and purpose to formal learning, students opportunity and access, and extend STEM content learning and student engagement (Roberts et al., 2018). Informal STEM learning experiences have also helped to make connection between schoolwork and daily lives for student participants (Baran et al., 2016). Informal STEM experiences can extend and deepen STEM content learning while providing opportunity and access to content, settings, and materials where students otherwise would not have access (Roberts et al., 2018).

Informal STEM summer programs can affect student interest and self-efficacy in STEM (Burwell-Woo et al., 2015). Within informal STEM learning experiences, (Bell et al., 2009; Elam et al., 2012; Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011; Kong, Dabney, & Tai, 2014; Mohr-Schroeder et al., 2014; Sahin, Ayar, & Adiguzel, 2014) participants have shown increased interest in STEM areas. Studies have examined the impact of an out-of-school (informal) STEM education programs on student attitudes toward STEM disciplines and STEM careers, finding that these programs contributed to student interest in STEM fields (Baran et al., 2016). Grigg et al. (2018) also indicated that self-efficacy can positively predict achievement in STEM areas.

Informal learning environments increase students' interest in STEM (e.g., Mohr-Schroeder et al., 2014) and may increase the student STEM career interests (Kitchen et al. Sci Educ 102: 529–547, 2018). The need to improve students' self-efficacy through STEM learning experiences is crucial to ensuring continued student interest in STEM careers (Halim, et al., 2018). Students that are exposed to STEM careers can increase interest in pursuing STEM careers (Blotnicky et al., 2018). The results of a study examining students participating in an informal STEM learning experience revealed an increase in their motivation and interest in STEM field, and an increased interest STEM careers (Mohr-Schroeder et al., 2014). Participation in informal STEM learning experiences such as clubs and competitions can be beneficial to the development of students in STEM careers. Results from a 2018 study showed that students who participated in a program had 1.4 times the odds of wanting to pursue a STEM career, controlling for background characteristics (Kitchen et al., 2018). These findings suggest that STEM summer programs that show the real-life relevance of STEM may be an effective strategy to inspire more students to pursue STEM careers. Students' knowledge about a profession influences their future decisions about careers (Ivey et al., 2015). For this study, results indicated that the collaboration between K-12 teachers and STEM professional was important to the success of the program.

Informal STEM learning experiences offer student participants the ability to learn new skills. Not only will informal learning experiences increase students' interest in STEM, but also support them in developing critical engineering problem solving and design skills (Ayar, 2015). Access and equity for underrepresented populations in traditional STEM classrooms can be addressed through collaborative partnerships that bring together formal and informal learning experiences (Hartman et al., 2017).

Denson et al. (2015) discuss themes the emerge showing the benefits of informal STEM learning environments for underrepresented students: informal mentoring, makes learning fun, time management, application of math and science, feelings of accomplishment, builds confidence, camaraderie, and exposure to new opportunities. As students spend the majority of their time outside traditional formal learning environments, it is critical that informal STEM experiences are developed and offered, so students of all backgrounds have opportunities to pursue STEM.

2.7 Chapter Summary

Minority populations are highly underrepresented in STEM fields (Howard et al., 2009; Jayaratne et al., 2003; NSB, 2006; NSF, 2013; Stake & Mares, 2000; Taningco, et al., 2002). Social Cognitive Career Theory (SCCT), as a career development theory (Lent, Brown, & Hackett, 1994, 2000; Lent, 2005; Lent et al., 2008) may be used to identify goal persistence for underrepresented populations and has been used to study career choice and persistence in STEM for underrepresented populations (Byars-Winston et al., 2001; Lent, Sheu, Gloster, & Wilkins, 2010).

The basic building blocks of Social Cognitive Career Theory are self-efficacy beliefs, outcome expectations, and goals (Lent et al., 1994). Self-efficacy is characterized by an individual's personal beliefs regarding his/her own capabilities in performing a task or to act/behave in a certain fashion (Bandura, 1986). Outcome expectations are the beliefs about the outcomes of performing particular behaviors (Lent et al., 1994). This model explains that people make choices about activities based on effort and persistence in the activity including self-efficacy beliefs. A person's intentions to engage in a particular activity such as seeking a major or career can be defined as a personal goal (Lent et al., 1994).

Informal learning environments can provide context and purpose to formal learning, students opportunity and access, and extend STEM content learning and student engagement (Roberts et al., 2018). Informal STEM summer programs can affect student interest and self-efficacy in STEM (Burwell-Woo et al., 2015). Within informal STEM learning experiences, (Bell et al., 2009; Elam et al., 2012; Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011; Kong, Dabney, & Tai, 2014; Mohr-Schroeder et al., 2014; Sahin, Ayar, & Adiguzel, 2014) participants have shown increased interest in STEM areas.

CHAPTER 3. METHODOLOGY

3.1 URM Student STEM Success

As the demand for a STEM workforce continues to increase, the United States Department of Labor (2007) asserts that America will not advance in STEM fields without investment and effort to supply STEM qualified workers. Preparing underrepresented minority (URM) students is a potential solution to the national need as minority enrollment in colleges increase (George et al., 2001). Underrepresented minorities in STEM fields refer to females, Black, Latino/a, Mixed, Native Americans or Alaskan native and native Hawaiian or other Pacific Islanders (National Science Foundation, 2017). Underrepresented populations refer to those populations with variables such as opportunity and access; race/ethnicity; Special Education; 1st generation; gender; F/R lunch; Zip code. To effectively examine how to increase the rate of URM student success in STEM, more research is needed on the factors that might contribute to minority STEM interest, self-efficacy and increase in career intentions (Teitjen-Smith, Masters, & Smith 2009). This chapter aims to introduce the research design, methods and procedures to conduct a qualitative study for the following research question: How does an informal STEM learning experience impact underrepresented minority students' STEM interest, STEM self-efficacy, and STEM career goals?

3.2 Research Design

After reviewing relevant literature and focusing on different methodologies, the choice of case study methodology surfaced as the best and most appropriate approach for the specific research questions. A qualitative approach best fits this study because it allows exploration, comparison and assessment of student attitudes and perceptions. In addition, some of the research design is of an exploratory nature necessary for qualitative studies. The research focuses on how informal STEM learning experience impact the interest, self-efficacy, and career interests (and goals) of underrepresented populations. This study looks at differences in how an informal STEM learning experience impacts underrepresented students' perceptions of their interest, self-efficacy, and career goals versus those of majoritarian students.

Though grounded theory, ethnography, narrative inquiry, and phenomenology were considered for this study, I selected a case study methodology because it is a way to explore real life phenomena through detailed, in-depth data collection (Creswell, 2013). Case studies focus on a particular phenomenon (Merriam, 2009).

The point of the case is to learn more about the particular phenomenon. A case study investigates a phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clear (Yin, 2014). Case studies are descriptive in that the final product results in a rich description of the phenomenon under study (Merriam, 2009). Case studies are heuristic in that they establish, extend, or confirm understandings of the phenomenon.

Flyvbjerg (2006) points out common misunderstandings about the validity of case studies and provides explanations to refute these misconceptions. Flyvbjerg identifies a misunderstanding in the perspective that places theoretical knowledge as more valuable than practical knowledge, while warning that case studies should not necessarily be summarized because value could be lost if not left as narratives. By leaving the research study in narrative form, readers are given practical knowledge, able to perceive their own interpretations and conclusions.

Creswell (2013) discusses the instrumental case study, collective/multiple case study, and intrinsic case study. Researchers use the single instrumental case study to highlight the issue of study. Kauffman (2021) used an instrumental qualitative case study to examine faculty perceptions to explore the improvement of student engagement and student success in the classroom. The intrinsic case study is used when there is a specific interest in the case itself. Weimer's (2021) intrinsic case study examined one novice music teacher's experiences using a self-created and produced podcast as a professional development tool. The multiple case study is used when several cases are used to highlight the issue of study. For example, Leyden (2021) used a collective/multiple case study to examine the experience of five students who attended a summer camp in Maine as both campers and counselors.

In choosing between these types, I have designed this study to use the multiple case study approach, to examine the same phenomenon in the same summer experience with different participants. Each student interview is considered a case within this multiple case study. These transcripts are bounded together as cases and selected to develop a more in-depth understanding of the student summer program experiences than one transcript that would be considered a single case might provide.

The multiple case study approach allows a focus on student STEM interest, STEM self-efficacy and STEM career intentions during an informal STEM learning experience.

3.3 Epistemological Assumptions Guiding Methodological Decisions

Epistemology is not only a way of understanding, but also a way of explaining how we know what we know (Crotty, 2003). It is concerned with the philosophical decisions that constitute what kinds of knowledge are possible and able to be known (Maynard, 1994). The concept can determine how I make meaning from the world. Within the philosophical framework of epistemology, knowledge is being constantly filtered through one's own lens and is therefore subjective (Denzin & Lincoln, 2005).

My perspective as a researcher is that the understanding of STEM education and engineering design is a human construction. The assumption it is created through the relationship between the STEM curriculum and the students participating in the STEM camp supports the epistemological stance that learning how to implement pre-engineering curriculum is done subjectively and interpretively through construction. Therefore, my epistemological stance is social constructionism. Constructionism is the view that knowledge is constructed out of human interaction within their world and transmitted in a social context. Therefore, meaning is not discovered within the human world. It is constructed in our world.

Because of this subjective epistemology, I equate knowledge with a given value and that knowledge is affected by interpretation. My subjective epistemology means that I believe interviewers can influence responders and responders can influence interviewers just as researchers can influence participants and vice versa. Qualitative research assumes that the researcher and participants should be interactive because knowledge is in the meaning people make of it and gained through talking about the meaning (Creswell, 1998). I believe that a qualitative researcher is part of the process of inquiry (Creswell, 1998).

3.4 Study Context

The See Blue STEM Summer Experience is the camp for elementary and middle school age students. The camp was first started in 2010, providing the region with an informal learning experience for students to enhance STEM knowledge and skills through authentic hands-on activities. University STEM faculty, STEM instructors, and camp staff led the content sessions. For the 2018 summer camp experience, students participated in robotics (e.g., Lego Mindstorm EV3) for three hours including other STEM content sessions such as DNA extraction, solar cells, and 3-D printing for an additional three hours each day. Students were able to explore, investigate and collaborate while applying the integrated approach to learning STEM while developing critical thinking and problem-solving skills. Students were provided with the opportunity to perform hands-on and problem-solving activities and gained experience with robotics activities. They were involved in building robot models, testing them, re-designing them, and retesting them. As students worked, they were encouraged to think critically to find solutions for given challenges. The structure of the robotics summer camp was grounded on collaboration, sharing, and active learning. Most of the students worked in pairs, collaborating, and developing interactions to make progress.

3.5 Study Participants

The participants in the study were overall participants in the 2018 See Blue STEM Summer Experience (Mohr-Schroeder et al., 2014; Roberts et al., 2018). Recruitment began through school identification, informational flyers, university camp website, social media, summer program recruiting event, and word-of-mouth in the region. The recruitment and promotion of the camp encouraged participation of underrepresented populations in STEM fields through incentives such as guaranteed slots in the camp, scholarships for attendance, and transportation to and from the camp if needed. For the purposes of this study, underrepresented minority populations refer to those students considered a minority by race/ethnicity.

3.6 Data Sources & Gathering

This study aims to uncover underrepresented student population's interest, self-efficacy and career goals through an informal STEM learning experience. Data from participants in the See Blue STEM Camp were used to assess how participating in an informal learning environment might impact underrepresented students' students' interest, self-efficacy, and career goals. The data collected were Student Interviews conducted with 2018 See Blue STEM Summer Experience participants (Mohr-Schroeder et al. 2014; Roberts et al. 2018).

3.6.1 Student Interviews

Interviews were conducted on the campus during the See Blue STEM Camp on Thursday afternoon or Friday morning of the camp. They lasted approximately five minutes. Two hundred and seventy-two students were interviewed using a structured interview protocol (Appendix A) during 2018 camp by a faculty or graduate student researchers on the project. Fifty-two of those student interviews were underrepresented students according to their self-identified race/ethnicity. During the end of the week, summer camp staff pulled students individually out of camp sessions for short interviews. Students were asked to explain what STEM means to them, what they would like to be when they grow up, what world STEM problem they would want to solve and why, how the camp may have prepared them for classes in school, what impacted their confidence during the camp, and questions about their enjoyment of the camp. A complete list of the interview questions is in the Appendix. Each participant interview varied in length depending on the participants answers; the interviews ranged from five to ten minutes. The structured interview questions and answers were audiotaped and then transcribed by project personnel. During the transcription, dialogue was recorded by typing exact wording; non-verbal cues were not included. Interviews were not timed. Participants were not afforded the opportunity to see the transcripts. The interview questions were used as a guide to probe responses and potentially gather detailed descriptive information. For example, when students were asked what they would like to be when they grew up, the follow up question was asking the student why they would choose that career. While a detailed description was not always provided by student participants, the open-ended questions did allow for detailed and descriptive answers. Interviewers were given the freedom to ask follow up questions that added clarity to the respondents answers, such as “Can you tell me more?”. By obtaining insights into what it might feel like to participate in this informal STEM experience, we can gain an understanding of how student participants might perceive the experience. The student interview protocol (see Appendix A) contained questions that were created by the See Blue STEM project development team to elicit responses that would make the students think about how the informal learning experience may have influenced them in multiple areas. For example, some of the questions asked about interest in STEM careers, or how the camp might have prepared them for their traditional STEM courses, while other questions asked about confidence levels during the camp and what they may have enjoyed during the experience. One question asked participants what STEM meant to them, without using the words (Science, Technology, Engineering, and Mathematics) that they normally associate with the acronym. These thought-provoking questions brought about rich dialogue from the participating students. For example, when asked problem would they solve in the world, students were given the opportunity to address an issue that was at the forefront of their mind. Additionally, when asked how they might solve this problem using STEM, they could respond with detailed information relevant to what they learned during the week. Interviews collected enabled us to determine how an informal STEM learning experience impacts underrepresented students' perceptions of their STEM interest, STEM self-efficacy, and STEM career goals.

3.7 Data Analysis Approach

Table 3.1, *Data Analysis Approach*

Research Question	**Data Collected**	**Data Analysis**
How does an informal STEM learning experience impact underrepresented minority students' STEM interest, STEM self-efficacy, and STEM career goals?	Transcribed Student Interviews	Open Coding Selective Coding Axial Coding Thematic Analysis

Data collected from the interviews were transcribed, analyzed, and coded in order to determine meaningful patterns and themes for formulation of inferences. Content analysis was performed to reveal repeating patterns or themes of interview responses. The repeating patterns were grouped together into coherent categories and assessed for more general concepts. Patterns and themes developed to support study related data.

3.8 Interpretation & Analysis Techniques (appropriate for approach and topic)

The theoretical framework for most qualitative research is an interpretivist/constructivist perspective. Qualitative research assumes the world is constructed, interpreted and experienced by the interaction of people within social circumstances (Maxwell, 2006). Therefore, the qualitative nature of my research is interpretive and best suited to understand a particular phenomenon (Farzanfar, 2005). Qualitative research is recognized for being a methodology that captures the complexity of human behavior and experiences. Given the lack of research with URM in informal STEM learning experiences, a qualitative approach lends itself to an in-depth and contextual understanding of the nature of these programs. This is one of the main reasons I chose a qualitative study. Data is verbal rather than numerical/statistical. Flyvbjerg (2006) also defends the generalizability of case studies. He disagrees that case studies do not allow for scientific development and tries to explain that case studies can function as tool to make assertions. The purpose of this qualitative research is not to generalize, but to understand a phenomenon in context. Qualitative methods are appropriate for this study because they provide direct access to participants' usually marginalized voices (Flick, 2018). For this research, I chose a qualitative study so that I could understand how informal STEM learning experiences could impact underrepresented minority students' STEM interest, STEM self-efficacy and STEM career goals.

In case study literature, it is often suggested there can be no preconceived notions or frameworks when conducting the research. As a researcher, I am aware of possible biases I might have based on my own prior experiences with teaching and education. Although qualitative research embraces the subjectivity of the researcher, I still find it necessary to document the ways that my biases may influence data interpretation. Within qualitative methods, research is impacted by the researcher. Therefore, I feel that it is important to disclose my personal history with the See Blue STEM Camp. As a doctoral student, I was enrolled in a course which enabled me to work during the summer with the program. I worked directly with student participants and staff, assisting instructors in all courses including robots. Knowing my previous history with the camp, I acknowledge my own assumptions, viewpoints, biases, and prejudices (Merriam, 2009; Moustakas, 1994) and constantly try to interrogate them, possibly asking myself, "Why do I think this/that?". This helped me to avoid subjective judgments and protect the "voices" of the participants. Working in education for over twenty years, I have had multiple experiences from substitute teaching, K-12 teaching in a science classroom, AP Biology instructor, tutoring ACT, department chair, undergraduate research and internship director, professional development leader, and summer programming director. Through all of my experiences, I have the hope that all the effort and industry that has gone into the programs I have been a part of, will in some small way affect the students the programs are designed for. It is a belief that I realize and fully admit. Maybe it is a hopeful view or considered overly positive or naive, but this view has kept me persevering in many of the challenges that I have faced in life. My viewpoint on learning skills and concepts is that this knowledge can often be transferred to new or future experiences. I am aware that I see any difficulty or challenge students might encounter as an opportunity to create perseverance and grit.

My history as an educator also gives me a teaching perspective where I can see the importance of empathy for students, and therefore all social and emotional skills. I believe in the old saying that students do not care how much you know until they know how much you care. With that being said, I do not assume that these students will share the same cultural and political perspectives. I know that not all of the students will come from “comfortable” backgrounds, and that the homelives of these student participants will be likely be different than my own experience. I expect all of the students to have a unique viewpoint of the world. And I do not expect students that are considered underrepresented minorities to share any specific references in regard to politics or religion. I also understand that while part of our identity is visible, others are invisible. I try to constantly reflect to make sure I am not making assumptions of students based on my own experiences. Even though I am categorizing students in this study, I understand that each student is a complete individual and I should not presuppose any assumption or viewpoint upon them. Once I identified my biases, I made every attempt to suspend these biases during the research process.

The qualitative analysis and interpretation began with reading of the transcripts (Saldaña, 2016). Using case study data analysis to search out concepts, I coded the data and found words and phrases that highlighted the most important areas of interest in the research (Allan, 2003). Coding qualitative data makes it easier to interpret, as words and phrases can capture what is meant in the response. I began with open coding, taking my textual data and breaking it up into parts, then used axial coding to draw connections between the open codes, and finally selective coding where I began to select the central category that would connect the codes that captured the essence of my research. I will explain each of these coding strategies in detail in the paragraphs that follow. These coding methods enabled me to find issues that were mentioned multiple times by the same respondent or by multiple respondents. Through organizing the information using coding, meaning was brought to the segments of data collected (Rossman & Rallis, 1998; Creswell, 2009).

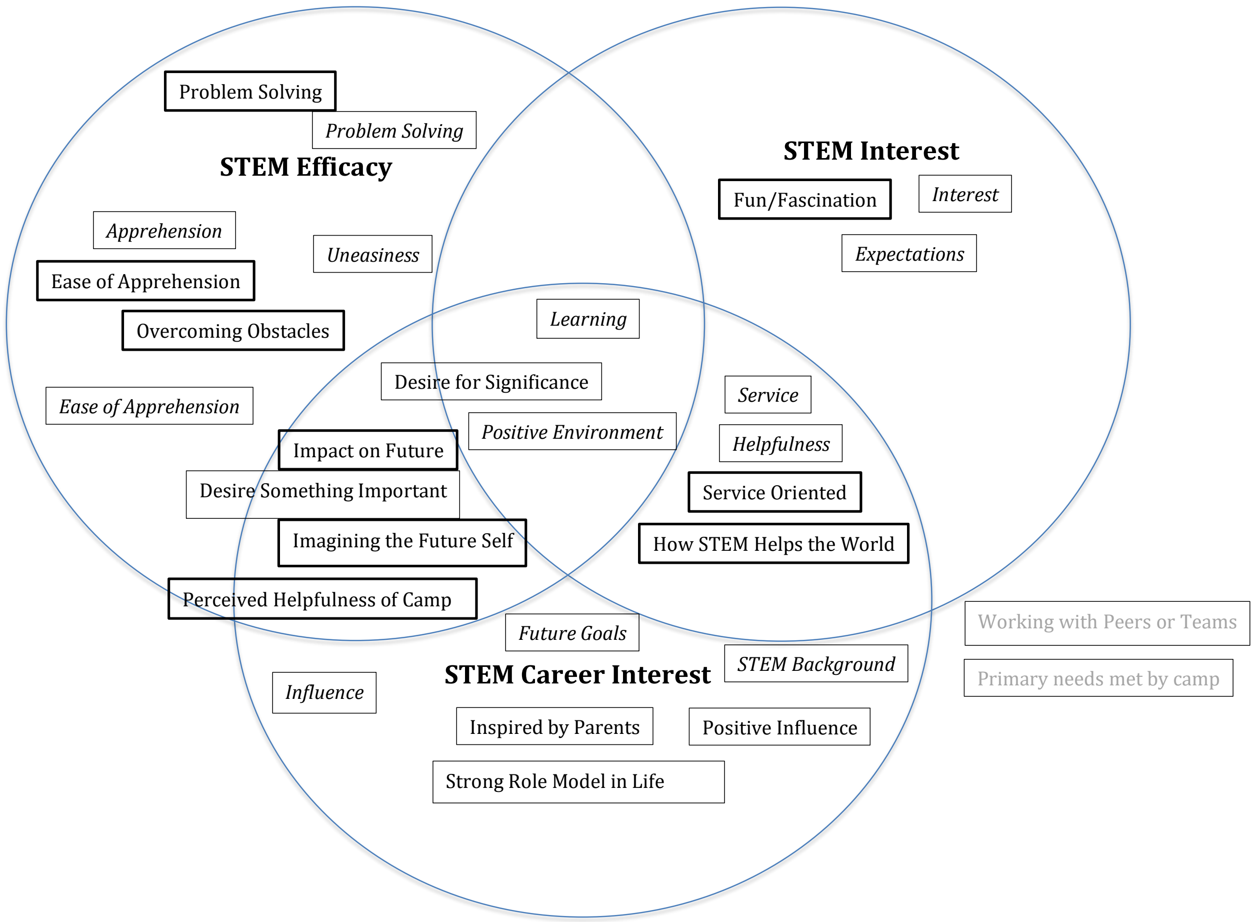
By examining, comparing, and categorizing the data through coding, the participant's views are conceptualized. I used the process of open coding to form categories about the phenomenon with segmenting information. During the open coding phase of qualitative analysis, I was able to organize the data in a way that makes sense according to themes that emerged through the process. I categorized data according to consistent phrases, expressions, or ideas that were common among participants (Kvale, 2007). I formulated some of the coding categories prior to coding and other codes naturally occurred during the coding process. The initial codes that were developed were created to help me begin the process of coding after reading the transcripts multiple times. These initial codes represented categories that might be expected from student participants during my time as a volunteer at the camp during one summer along with insights from my literature review.

Table 3.2, *Initial Codes vs Naturally Occurring Codes from participant interviews*

Initial Codes	**Naturally Occurring Codes**
Influence	Apprehension
Learning	Problem Solving
Interest	Uneasiness
Helpfulness	Ease of Apprehension
Future Goals	Positive Environment
Expectations	Service
	STEM Background

As a step to establish the stability of the codes, a third party reviewed the codes to alleviate bias, and obtain constructive feedback (Creswell, 2007). The open coding began the process of analysis and lead to axial coding to assemble the data in new ways, determining a category arrangement. In the selective coding phase, the categories were integrated into the axial coding model that connected the categories into a “story line”. I evaluated the data for similarities in the codes and develop thematic categories (Saldaña, 2013). This added to my perception of what students perceive as ways that their interest, self-efficacy and career interests/goals have been impacted. In axial coding, I was able to present a coding diagram in a visual model. This type of coding identifies central phenomenon (i.e., central category about the phenomenon), which may have not been known, and can allow the coding to explore causal conditions.

Figure 3.1, *Coding Diagram (Codes, Assertions & Constructs)*



When the diagram was completed, categories that influence the phenomenon and the interactions that result from the central phenomenon could be seen. The initial and naturally occurring codes are shown in italics, while the assertions that emerged were categorized and grouped together surrounding constructs of Social Cognitive Career Theory. This model was used as a visual representation of the relationships among categories. As a result, assertions and subthemes emerged and were categorized. I used quotes to support the themes within the discussion. These supported assertions were the foundations for propositions or ideas predicting thematic relationships.

I formed central themes from the data of each participant. To do this, I extracted significant statements or phrases from the data. I looked for repeating ideas, any specific participant terminology, any shifts or patterns, in particular connections (Saldaña, 2013). Looking at common elements and in relevance to research questions, I used the significant statements to form central themes to help interpret the data. The codes led to categories and constructing of themes. Coding of the transcripts allowed for the phenomenon to be studied in such a way that participants' experiences, interpretations and perspectives were elicited from the data by breaking down the interviews.

These coding processes were not sequential and did overlap to obtain the best possible data relevant for the research. I continued the process multiple times until I had a strong understanding of the concepts. I continued a constant comparative method to validate the relationships between the categories that are established in coding.

I conceptualized, classified, categorized and identified themes, patterns, sequences, and differences throughout each participant's answers/responses. I was able to connect interrelated data. Using these connections, I am able interpret and provide meaning to the data by using the codes to connect to themes. Through the iterative process of coding and thematic analysis, themes were identified associated with each part of the research question. Themes associated with STEM Interest consisted of fascination, and how STEM helps the world. Themes associated with STEM Self-Efficacy consisted of overcoming apprehension/uneasiness, ease of apprehension, perceived helpfulness of camp, and problem-solving. Themes associated with STEM Career Interests consisted of imagining the future self, impact on future, and service oriented. This meaning is presented in the themes that emerged below. A concept map was useful in visually representing the findings and connections within the findings. This added insight to the collected data. A comparison was then made to relevant literature concerning Social Cognitive Career Theory constructs. The findings were used to determine the appropriate way of displaying the data to reveal new patterns. This enabled information that might be missing or additionally useful to be seen.

Table 3.3, *Emerging Assertions Corresponding to SCCT Constructs*

SCCT Constructs	**Assertions**
STEM INTEREST	Fascination/Fun
	How STEM helps the world
STEM SELF-EFFICACY	Overcoming Obstacles
	Ease of Apprehension
	Perceived Helpfulness of Camp
	Problem Solving
STEM CAREER INTEREST	Imagining the Future Self
	Impact on Future
	Service Oriented

Themes were then constructed by collapsing the assertions by refining down to concepts that were similar. The resulting concepts that were most prevalent were:

Engagement, Service, Confidence, Future Thinking, and Cognitive Thinking. Some themes were associated to more than one Social Cognitive Career Theory construct.

Figure 3.2, *Visual Diagram of Codes, Assertions & Associated Constructs*

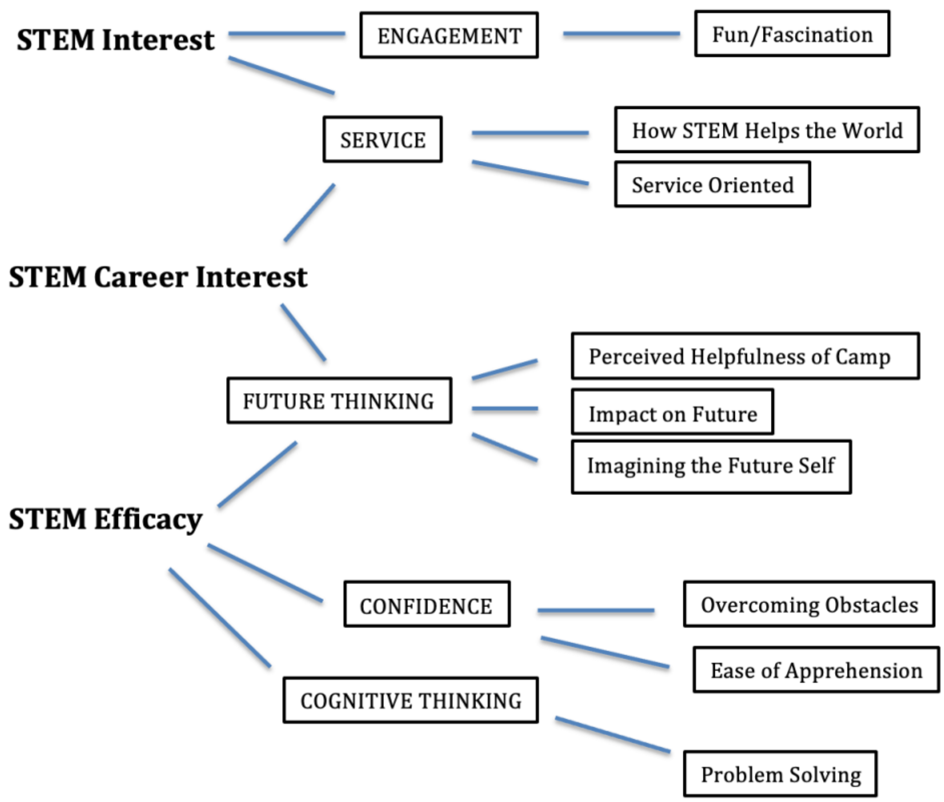


Table 3.4 exhibits the collapsed themes associated with multiple Social Cognitive Career Theory constructs.

Table 3.4, *Themes Corresponding to SCCT Constructs*

Theme	SCCT Constructs
ENGAGEMENT	STEM INTEREST
SERVICE	STEM INTEREST STEM CAREER INTEREST
CONFIDENCE	STEM SELF-EFFICACY
FUTURE THINKING	STEM SELF-EFFICACY STEM CAREER INTEREST
COGNITIVE THINKING	STEM SELF-EFFICACY

3.9 Chapter Summary

Methodology includes research design, methods and procedures to conduct a qualitative study. Data from participants in the 2018 See Blue STEM Camp were used to assess how participating in an informal learning environment might impact underrepresented students' interest, self-efficacy, and career interests. The data collected were student interviews conducted with 2018 See Blue STEM Summer Experience participants (Mohr-Schroeder et al. 2014; Roberts et al. 2018).

Using case study methodology, data analysis to search out concepts, the data were coded and organized to bring meaning was brought to the segments of data collected

(Rossman & Rallis, 1998; Creswell, 2009). By examining, comparing, and categorizing the data through coding, the participant's views were conceptualized into themes.

CHAPTER 4. RESULTS AND ANALYSIS

4.1 Analysis of Results

In this chapter, I analyzed the experiences of underrepresented adolescents who participated in a 2018 summer STEM robotics camp to answer the following question: How does an informal STEM learning experience impact underrepresented minority students' STEM interest, STEM self-efficacy, and STEM career goals? Utilizing structured interviews, this chapter represents a qualitative analysis of unified themes and sub themes regarding how informal STEM learning experiences can impact underrepresented participants' STEM identity, STEM self-efficacy, and STEM career interest.

Participants interviewed included fifty-two (52) (20 %) of the two hundred and seventy-two (272) camp participants in the minority population of the camp as determined by completed demographic information. Student were enrolled in grades 5-8. Three of the interview transcripts were thrown out due to non-substantive language such as "I don't know" and "Umm".

In structured interviews, camp participants were asked about their perceived STEM interest, STEM self-efficacy and STEM career interest. The research question aims to determine how the informal STEM learning experience impacts underrepresented populations during the two weeklong programs. Although the interview questions were asked to nearly all camp participants, the focus of this study is to understand the influence of the informal STEM learning experience on underrepresented populations. My first step was interpreting the data that was gathered during the interview process.

To analyze these data, the interviews were transcribed by STEM Camp staff and uploaded to a cloud-based storage. For the qualitative analysis process, I organized and prepared the data by downloading and placing the data into accessible folders. After looking through the transcripts, I took out the “uhm”, “uh”, “um”, and unnecessary use of “like” from the participant responses. I left the ellipses in the transcripts to demonstrate a pause in the response or in thought, or a possible thought change. I began with a systematic approach to inquiry to include the process of looking for relationships in data, but yet being open to all possibilities. To make “sense” out of what was uncovered, the data was compiled into sections, also known as codes (Creswell, 2003, 2007). Each code is shown with a definition of what the code meaning and an illustrative quote from the participant interviews.

Table 4.1, *Code Definition and Illustrative Quote*

Codes	Definition of Code	Illustrative Quote
Influence	Participant was influenced either in STEM engagement and/or in the meaning of STEM.	"About .. like learning more of the basics of robotics .. or learning like the physics of flying, like the paper airplanes .. things like that. Those made me feel more confident because now I know more and I feel like I can spread my knowledge"
Learning	Participant experienced learning in some way during the time at camp.	"I like how it was, fun and interesting, and it was …educational, so we learned stuff by having fun."
Interest	Participant shows interest in topics, concept, or activities in the camp.	"I really like the hands-on activities, it's cool that we really get to do that, which it's just worksheets, but here it's a lot more hands on and I like that."
Helpfulness	Participant expresses that the topics, concept, activities or STEM could be helpful in some way.	"Well, we could use new, new technology and science, that kind of stuff…especially to cure diseases, that kind of stuff to keep people alive."
Future Goals	Participant discusses future goals related to STEM.	"A mechanical engineer…because it's fun to create things or make things you own. Or make things better and fix things for everyday life so people will enjoy it."
Expectations	Participant changes expectations associated with performance.	"…Cause first time programming something it's not gonna work out…and sometimes you might have to do \ 23 attempts to get it right."

Codes	Definition of Code	Illustrative Quote
Apprehension	Participant felt apprehension before or during the experience.	"Just getting comfortable at this camp. Never having been here that's one thing but getting used to being here. In robotics a lot of people have been here over the years so just getting used to this place."
Problem Solving	Participant shows problem solving abilities	"They make use to…to fully use our brain and not to have half-step things…Only that I can problem solved in robotics and everything…problem solving over the other things."
Uneasiness	Participant felt uneasiness before or during the experience.	"… One thing that made me less confident is when me and my partner kept trying and trying and trying to get this piece to fit in and it took us nearly thirty tries, halfway through, my fifteenth try I felt really less confident… what am I doing wrong that's making it not click."
Ease of Apprehension	Participant expressed an ease of apprehension during the experience.	"I got better at programming and we completed our challenge."
Positive Environment	Participant felt that the camp was a positive environment.	"I really like the science and stuff that we learned and …engineer…and robotics mostly because we get to program the hu…robots and make them do different changes…which I haven't got to in…my school."
Service	Participant seeks to be of service.	"Maybe I could build a machine for people if they can't walk or speak or translate…like a translator…maybe a prosthetic part of their body…to help them."

Codes	Definition of Code	Illustrative Quote
STEM Background	Participant has a previous background in STEM	"…Because it, my dad is materials engineer and he gets to do a lot of cool stuff within his work so I want to be able to do that too…I can use the tactics and stuff, that I've learned, the places that we've been, people who are already materials engineers they've seen, that I can use that to apply in my everyday life."

To accurately understand the results of this study, we must revisit the assertions, themes, and corresponding SSCT constructs below in Table 4.2 and Table 4.3.

Table 4.2, *Assertions and Corresponding SCCT Constructs*

SCCT Constructs	Assertions
STEM INTEREST	Fascination/Fun
	How STEM helps the world
STEM SELF-EFFICACY	Overcoming Obstacles
	Ease of Apprehension
	Perceived Helpfulness of Camp
	Problem Solving
STEM CAREER INTEREST	Imagining the Future Self
	Impact on Future
	Service Oriented

Themes include Engagement, Service, Confidence, Future Thinking, and Cognitive Thinking. Each of these assertions is collapsed into a theme and are associated with constructs of the Social Cognitive Career Theory.

Table 4.3, *Themes Corresponding to Assertations and SCCT Constructs*

Theme	**Assertions**	**SCCT Constructs**
ENGAGEMENT	Fun/Fascination	STEM INTEREST
SERVICE	STEM Helps the World Service-Oriented	STEM INTEREST STEM CAREER INTEREST
CONFIDENCE	Overcoming Obstacles Ease of Apprehension	STEM SELF-EFFICACY
FUTURE THINKING	Helpfulness of Camp Impact on Future Future Self	STEM SELF-EFFICACY STEM CAREER INTEREST
COGNITIVE THINKING	Problem Solving	STEM SELF-EFFICACY

Although many of comments from the transcripts are used in the narrative to illustrate assertions and themes in this chapter, there were participant comments not included in the results section. Even though the excluded comments from transcripts were consistent with the narrative, they were also repetitive. The total number of times each theme is referenced in the 49 transcripts is listed below.

Table 4.4, *Themes Referenced in Transcripts*

Theme	**Total Number of Times Referenced in Transcripts**
Engagement	71
Service	29
Future Thinking	64
Confidence	66
Cognitive Thinking	52

4.2 STEM Interest.

Interest has been identified as the primary factor that influences career choice (Miller et al., 2018). This aspect of the research question examines how an informal STEM learning experience impacts the STEM interest of underrepresented minority student participants. This question was explored through student fascination/fun in the overarching theme of engagement. The most frequently noted assertion pertaining to STEM interest involved Fascination/Fun. Each camp participant was able to discuss how the informal STEM experience led to statements that related STEM to fascination and fun, expressing that camp participants enjoyed activities and the work they accomplished in the camp. Of the camp participants that spoke about how fun the camp experience was, it is noted that campers used words like “fun”, “amazing”, “exciting” and “interesting”, in addition to expressing they wanted to know more about multiple topics.

4.2.1 Engagement

The theme of engagement was expressed through the enjoyment and excitement shown by campers who participated in the STEM camp activities and experienced fascination and fun. Some questions in the interview were more able to elicit responses from students discussing their thoughts and feelings. These questions included: “What does STEM mean to you?”, “What have you enjoyed about STEM camp so far?”, and “What do you want to learn more about?” The questions listed were able to point what students found enjoyable.

Other questions brought about emotions and feelings of excitement from students to also express engagement. For example, when asked what STEM means to you, Shanelle said, “STEM means to have fun, because Science, Technology, Engineering, and Math are all fun to me.” Shanelle was associating STEM with fun. Virginia was asked what STEM means to her.

> Well, I think it means science, technology, engineering, math and FUN. Because I mean there no F there, but you know it’s not STEMF…but… I really like STEM stuff… especially the M part because I love math. It like makes me sense in my brain or whatever you wanna call it…but I really like STEM which is why I’m at STEM camp…cause you know…STEM’s fun.

Virginia's excitement was evident in her response. Not only did she mention a component of STEM, her affinity for math, but she also noted that she was attending STEM camp because she related being at the camp to having fun.

There was also an association of fun with overall educational learning. Satchel said, "I like how it was, fun and interesting, and it was …educational, so we learned stuff by having fun." Satchel commented on how they were having fun, but also learning. I think it is noteworthy that Satchel made a point to draw this conclusion, as if to say that *even though* they were learning, they were having fun.

In addition, participants enjoyed specific activities. Javin said, "I've enjoyed chemical engineering…making chapstick". Javin drew connections to an activity that was involved in chemical engineering which was the manufacturing of materials. Erika said what she enjoyed most about STEM camp so far was,

> "I think it's the part on the robotics…like it's really fun, like program, and figure with things…I kind of like building things. I also like the science and the math portions that we've done. Like the things that we did in the afternoon like drawing other people, that was fun…like touching the body parts. That part was really fun. That was probably my favorite."

There were so many activities that Erika enjoyed, it was difficult for her to name only a few, let alone one. It was as if she was pulling all the fun experiences from memory and listing them verbally as they came to mind. Zoey also had a list of activities that she enjoyed. She said, "Coding…and building the robot, and scribble bot, that was really fun…I also like the 3D pens." It would not be a stretch to deduce that her time at

STEM camp was enjoyable because she was associating STEM with fun. Fun and excitement was identified in many of the student interview transcripts. Students learning can depend on engagement; when activities are fun, students are more likely to be engaged. It is important to mention that it is plausible that student who were having fun, may have become more fascinated in the topics at the STEM camp, which could have led to increased interest.

Participants expressed fascination in that they were enjoying activities and wanted to learn more about those particular topics. When asked what they enjoyed about STEM camp so far, Breaja said, “I’ve enjoyed the friends I’ve made and learning how to make engineer things and stuff like that…I want to learn more about technology and programming, robotics and things like that.” Breaja wanted to learn more about the topics she was introduced to in the STEM experience. Her need to want to learn more showed her interest and fascination in those areas. Taylor stated that she would like to learn more about, “I think more about solar panels, and energy…maybe …more about robots… And more about different types of engineers.” Although Taylor was exposed to a few different types of engineers, she knew that there were different kinds of engineers that she had not yet been introduced to. This was a need to know more.

Camp participants also enjoyed the way they seemed to be learning through hands-on activities. Annika stated, “I really like the hands-on activities, it’s cool that we really get to do that, which it’s just worksheets, but here it’s a lot more hands on and I like that.” The use of the word “cool” suggests that she has interest and looks at these topics as fascinating, something that she would like to continue learning about. Annika continued, “I really want to learn more about chemical engineering because we tried that yesterday and it was really interesting to me." Again, Annika was introduced to an idea in STEM that she had never learned about before. With this new interest, Annika may seek out information regarding chemical engineering with a possible foundation to contextualize what she learns about the topic in the future. Evan said, "It's learning new things, and trying out new things, and we made a bouncy ball, Chapstick, we made products that they could put to good use." Evan's comment about "trying out new things" suggests that he is now able to look at learning as an adventure. This could enable him to think about becoming a possible inventor or innovator.

This was the first experience for some students attending camp. This was Jessica's first time attending a STEM camp with embedded robotics. Jessica mentioned, "I'm a very tactile learner, meaning that robotics or visual learning is sort of iffy for me and this camp being all hands-on learning is really amazing for me cause I can pay attention a lot easier, and it's just a lot more fun for me." Jessica is using words like "amazing" and "fun" to show how she is having more fun with the hands-on learning. Jessica also seems to be comparing her informal summer learning experience to other "iffy" learning experiences. At times, other students related that the informal learning experience may have been different than their formal learning. Leviticus reference his favorite aspect of camp saying, "the hands-on…the hands-on teaching cause at the same time, they let us do fun things…they let us do fun things as… as their... as their information sink in on us." Leviticus seems to imply that while they were doing something fun, they were also learning through "information sink"[ing] in.

Some responses showed an explicit appreciation for the fun activities that were not readily done in their traditional classroom. Grecia mentioned that she enjoyed so many activities due to those activities being exclusive to the camp, “I really like the science and stuff that we learned and …engineer…and robotics mostly because we get to program the hu…robots and make them do different changes…which I haven’t got to in…my school.” She wanted to learn more about, “Maybe get more into detail with programming…and knowing more about ….how to do different challenges…like we’re doing right now…but we didn’t…we just had a week…we didn’t get to…a lot of stuff and I would like to…continue that…programming.”

4.3 STEM Career Goals.

According to Social Cognitive Career Theory, career development occurs as a result of self-efficacy, outcome expectations and personal goals. This aspect of the research question examines how an informal STEM learning experience impacts the STEM career goals of underrepresented minority student participants. Social Cognitive Career Theory (SCCT) focuses on the development and influences of occupational choice (Brown & Lent, 2013). The framework explains how one develops occupational interests to make career choices (Lent, Brown, & Hackett, 2002; Brown & Lent, 2013), and is a basis for understanding occupational and educational behavior. Personal goals are part of a person’s intention involved in an activity and career development (Brown & Lent, 2013; Olson, 2014). This construct was explored through the theme of Service in addition to Future Thinking.

4.3.1 Service

In conjunction with engagement, camp participants were able to show their interest in STEM and STEM careers by acknowledging how they might be of service in the world of STEM. This theme was evident in many campers’ discussion of the activities they participated in. One question in particular asked, “How will you use what you’ve learned in STEM camp to make the world a better place?” Other questions that were coded for this theme of how STEM helps the world included: “What do you want to be when you grow up?” and “Why are you interested in this?”

Some participant’s explanation lead to the development of multiple assertions after analyzing their responses. For example, Christian said, “During robotics it’s sort of interesting using the programming and stuff and for chemistry and engineering you have to learn different types of solutions and stuff…or different types of chemicals… engineering…” Christian is expressing his interest in the STEM activities, and then comments on how these activities are not just interesting and fun but can be helpful. Christian continues, “Use it in, use it for people who need help with something or if you want to have fun with it, you can do it, but yeah, that’s what I would use it for.” Christian’s responses seem to almost make the connections as he was verbalizing them.

After being asked how you will use what you’ve learned during STEM camp to make the work a better place, Annika responded, “Well, we could use new, new technology and science, that kind of stuff…especially to cure diseases, that kind of stuff to keep people alive.” Annika could see the way what she was learning in STEM camp could make an impact on others in a specific way. Though there were no formal discussions during camp on this subject, Annika made those associations because of the inferences she was making in understanding all aspects of STEM. In addition, Jenaya said,

> “So today, we learned about airplanes like airplanes and stuff. And …we can use different types of airplanes to for the fuels…and …you have the fuel ones and you

> have the battery ones… we've different types of battery. And I think if you use …the battery ones instead of the fuel ones, then it might throw a better place cause fuel has more pollution than batteries."

Jenaya was using her knowledge of what she was learning in STEM camp to develop ideas about environmental impacts due to innovations. She was drawing connections to the world around her.

Within Social Cognitive Career Theory, the choices that people make and the actions that people take that are related to those choices are influenced by their interests (Lent, Brown, & Hackett, 1994). Imagining themselves and their impact on the future, camp participants showed a desire for significance and being service oriented. Julien said, "I want to be a biomedical engineer…because I want a job that help people with and engineering is one of the main things of really just helping everyone or helping people." Julien could see how his career choice could be of service to others. Jessica said,

> When we did the tour in STEM camp of the engineering building, I learned a lot more about what I was able to do with all different jobs. I didn't know there was a job working here you know, designing unmanned vehicles all day, and I thought it was really awesome. So, we can design new technology for companies like Amazon to help make things easier, and you can make things quicker and faster, maybe use less resources so instead of having to power a car with gas or something, you can find another way to power a drone using batteries and make things a lot more proficient…and overall, just better.

Jessica saw being service oriented as “just better” and could relate her new knowledge of careers to environmental concerns, and even efficiency. It is clear that her horizons were expanded with the knowledge regarding careers that she once did not know existed.

According to SCCT, self-efficacy influences interest in STEM and STEM career goals (Brown, 2002). Kayla showed a high self-efficacy in previous responses, and when asked about how STEM can make the world a better place, Kayla said “How we learned how to make robots and how they move and work, you can make robots to help problems in the world by, like in the hospitals or people have disabilities” remarking on potential STEM careers. Taylor also mentioned how she desired to make a significant difference in the lives of others,

> Well, we…I could probably use what I’ve learned in robotics class to make the lives easier for people…and…we could…maybe mass produce solar panels…the ones that we had in chemistry and to help energy… I mean to make more energy safely.

Taylor and Kayla both used aspects of concepts they were learning, related them to a career field and expanded their thinking to examine how they might impact others in the future through service.

Overall, camp participants gave specific examples of how they would each contribute to the world through STEM and what they have learned during this informal STEM learning experience. Jessica L. wants to use what she’s learned in STEM camp to make the world a better place. She said, “Maybe I could build a machine for people if they can’t walk or speak or translate…like a translator…maybe a prosthetic part of their body…to help them.” Joseph wants to use what he’s learned in STEM camp to “help people…like their… bodies and everything. I help them with their bad feelings. So, if there's tumor in their brain…help fix brain diseases." From mechanical to cellular engineering, camp participants gave examples of how they might contribute to society.

Campers were informed more about how STEM careers could be helpful in the world during the camp experience, so it was not surprising to see some of the camp participants answer questions explain multiple options of how STEM could make the world a better place. When asked this, Sebastian said, "Stuff like the medicine, like medicine, chemical engineering, that could help with the medicine and stuff, and physical engineering, that helps with transpor…transportation and stuff like that for the people."

Even when camp participants did not know exactly what they wanted to be, they still desired to do something important, of significance, that was helpful to others. Annika said, "Well to me STEM is like career option and you, it's also something that I see in our everyday world a lot." When asked what to you want to be when you grow up, Annika said, "I really don't know, I think it's too early to start any of that but, if you really asked me, I think it's really I want to do something to help the work and make it a better place I think." According to Social Cognitive Career Theory, the point when students have high self-efficacy and positive outcome expectations, they tend to develop interest in an activity, and subsequent goals that increases involvement in the activity (Brown & Lent, 2013). Even though some of the camp participants did not have an exact STEM career goal in mind, their responses showed high STEM self-efficacy with an interest in STEM.

4.3.2 Future Thinking

Within SCCT, career development is dependent on self-efficacy. It is the belief that one will perform well in a career. If one believes this, then there will be an impact on your choices. Careers are about thinking about the future. One will think about outcome expectations because that is what is expected to happen in the future. And finally, career development is influenced by what goals are set. Imagining a future self could relate to a goal that has been set. Many of the camp participants were able to answer the interview questions and distinctly focus on their perceived future self. Questions such as “What do you want to be when you grow up?”, “Why are you interested in this?”, and “How will you use what you’ve learned in STEM camp to make the work a better place?” were important questions that allowed campers to imagine their future self and think about how the informal STEM learning experience has impacted their lives.

According to SCCT, one’s beliefs about themselves are a strong determining factor of career interest, pursuit and the career realization. If one does not believe he or she can succeed, then the low self-efficacy will drive the development of career interests, goals, and actions to another path. And if one does believe he or she can succeed on that path, then high self-efficacy will continue to drive the development of those same career interests, goals, and actions on the existing path. When asked what she wanted to be when growing up, Breaja said, “a mechanical engineer…because it’s fun to create things or make things you own. Or make things better and fix things for everyday life so people will enjoy it.” Breaja is using the fun and fascination of the STEM camp to think about what she wants to be when she grows up to make things that will impact the world. There were multiple assertions throughout her answer, but the major assertion that prevailed was that of her imagining her future self.

Other students were able to imagine their future self as well continuing to include other assertions such as impacting the world. When asked what STEM means to you, Evan said, “It means, well it’s education things were you got science, technology, engineering and mathematics and they all kind of work together and, there are careers that come with those subjects…” A follow up question asked Evan what do you want to be when you grow up. Evan responded, “I probably wanna be, maybe an engineer…because they can help people, it would make the world a better place, and they can make new things and improve things, and it’s pretty cool I think.” Again, there were multiple responses that encapsulated many assertions within one response. Evan was imagining his future self and all of the ways he would affect others by serving in that STEM career.

When Jessica was asked what to you want to be when you grow up and why are you interested in this, she said,

> Either a neurologist, aerospace engineer, or mechanical engineer. The topic’s really interesting, when you become an aerospace engineer or mechanical, it’s just really interesting to me how you can incorporate math and physics in designing something so cool, such as designing and creating drones or being able to launch something into space with mathematics… I thought it was cool and just how brains work in general is just is just really awesome.

Jessica was imagining multiple versions of who she could be and what she would be able to accomplish through those career paths.

Even those students who had been introduced to engineering and careers in engineering prior to the camp were able to apply what they learned to the idea of their future self. Most of these camp participants had close, strong mentors in their lives. Beeva said she wanted to be

> "a materials engineer…Because it, my dad is materials engineer and he gets to do a lot of cool stuff within his work so I want to be able to do that too…I can use the tactics and stuff, that I've learned, the places that we've been, people who are already materials engineers they've seen, that I can use that to apply in my everyday life."

In this way, the informal STEM learning experience was solidifying Beeva's career goals, rather than just introducing her to them.

Some students seemed to find their passion during the week of STEM camp. One student, Elijah, was asked what he would like to grow up to become, and he said, "a designer of maybe airplanes and stuff." He continued on showcasing his fascination with this interest, "It seems really cool…and I want to know how stuff works…especially planes. I like to build and make planes fly." As Elijah was asked more questions regarding how STEM camp has prepared you for the classes that you'll take in school, Elijah responded, "It taught me how to make a glider" and reminded the interviewer of his favorite activity, "the gliding course… with airplanes? I forgot his name…yeah, aeronautics." Elijah was excited about this topic and he felt confident about his abilities.

His increased self-efficacy lead to an interest and STEM career goal. Self-efficacy has been identified as a key factor in persons choosing a STEM career (Tuijl & Molen, 2016).

In addition to imagining their future selves, camp participants were able to express how they felt their experiences would impact their future. When a student can develop high self-efficacy and positive outcome expectations, the student will persist to overcome barriers, and be more likely to have a career in that field (Bandura, 1977; Brown & Lent, 2013). When asked in what ways STEM Camp was preparing them for classes they take in school, Isaiah said, "Lots of much different things, like we don't have robotics at my school." Although this answer was brief, the camper was explaining that he knew being introduced to a STEM topic that was not offered at her school would be impactful to his future. Taylor's response showed that she was being introduced to topics and also receiving a more thorough quality of learning. She said, "Well …it's definitely preparing me for robotics 'cause I've never ever done robotics before…and this was the first time…and now I have a little background information and now it's much better. And I've never worked… actually worked with chemistry so this is also another thing." Breaja was expressing the same idea, "We have different classes where we learn different things, so that every day is not the same schedule. We don't see the same things, it's different, that way we can learn something new every day."

Participants expressed that not only were the topics and activities in the summer program different as compared to their traditional school courses, but also that there was a different quality of learning within the informal STEM learning experience. Julien said, "I want to learn more math, and I want to get further into the job that I want to be when I grow up." Julien knew that learning the applied mathematics skills in this program could assist her in reaching her career dreams.

Camp participants seemed to understand how the STEM camp was helpful in multiple ways. Some campers felt the camp could assist in their current traditional school courses. Zoey said, "I'm in advanced math class and …so if I learn math here it will prepare me for that." Zoey was able to connect the two experiences. Evan stated, "I can use the skill that I've learned by knowing what they do, like what type of education you need to get, the classes you need to take, err, yea." Although Evan was relating what he was learning about in STEM Camp to career fields and potential career paths, he was still drawing connections and perceiving the helpfulness of the camp to him specifically. Jayden said, "Well…the first semester of next year I'm having a robotics class which obviously this will help with that since this is a robotics camp…but a lot of the things we used, especially the applied mathematics would help in my core classes too." Again and again, camp participants related in multiple ways, how this informal STEM learning experience could assist them. For many, they could see how a skill could assist in another subject matter, or how a topic could be the foundation of a course they take, or even how they might learn about various careers that would have been otherwise unknown to them. Jessica could see the big picture and was able to longitudinally discuss the helpfulness of the camp, "If we're talking about middle school, it will just like help me engineer, just set up knowledge and help me look in their perspective. If we're talking about high school, it will help me think of classes I can prepare for in college and things I need to pay a lot of my attention on, and maybe even take some extra-curricular tie off to study or even do some other camps with things like that to help me prepare myself."

Luke's first introduction to engineering was this camp. "In school we have math and science, and this helps me a lot with that. We also have technology, that also helps. And for engineering, we don't have that class yet, but once we do, this will give me information for that." Luke expressed that he knew being exposed to engineering prior to learning about the topic at school would be useful.

Another student seemed to have a profound understanding of the interaction of science, technology, engineering and mathematics. Madeline was able to discuss how each concept was interdependent on the other, "Well, it's like science is…well, all of these things combine, we use them a lot, like science you need technology and sometimes engineering and math for science, and like technology can't really function without science, engineering, and math. So, it's like they all need each other."

4.4 STEM Self-Efficacy.

According to the SCCT model, an individual's interest, particularly in STEM, is directly influenced by the confidence in their ability to succeed in accomplishing tasks (Hardin & Longhurst, 2015). The interviews showed instances where campers discussed specific activities and situations while also showing increased motivation and belief in themselves to accomplish a task (Bandura, 1986). This aspect of the research question examines how an informal STEM learning experience impacts the STEM self-efficacy of underrepresented minority student participants. In addition to future thinking, this construct was explored through assertions of confidence and cognitive thinking. Participants were asked questions such as "What happened this week that made you feel less confident?" and "What happened this week that made you feel more confident?", in addition to questions such as "In what ways is STEM camp preparing you for the classes you'll take in school?" The prominent assertions that help answer this part of the research question mostly show camp participant successes that sometimes started as failures, and are verbalized at times through the narrative of the interview. Some of the instances where camp participants discussed successes showed overcoming obstacles and/or easing appreciation during an activity. Camp participants pushed themselves through difficult challenges and showed perseverance.

Assertions also included perceived helpfulness of the camp and problem solving. The interview excerpts allude to camp participants feeling that they had the ability to succeed in other situations due to their ability to succeed in similar future situations. These assertions did include peer interaction as teamwork as well. When asked what made you feel more confident this week, Jasmine stated, "Partnership. Working with someone, getting their opinions on stuff." Student participants enjoyed working with peers or teams; participants felt as though they could succeed in situations due to their work with another participant.

Abilities and capabilities are secondary to an individual's need for self-efficacy when measuring success in STEM fields (Byare-Winston et al., 2010). Many of the students alluded to perseverance and the willingness to be wrong and fail prior to success. When Virginia was asked how would you use what you've learned at STEM camp to make the world a better place, she answered,

> Well, the first day we did a ton of origami which really…which is geometry…which kid of helps you understand structures…and so I feel I'll understand you have to have a base and …but also with robotics I'll use the skills

> that …perseverance, 'cause first time programming something it's not gonna work out…and sometimes you might have to do 23 attempts to get it right.

She later said in the interview that this at first made her feel less confident, "it took me 23 tries to get our robot to spell CATS and so I was …you know it didn't work out that well…but I mean I feel …. practice makes perfect, so…" Virginia can see that it can take multiple tries at a task to complete it. This can be an encouraging lesson for any learner.

When asked what happened this week that make you feel less confident, Julien responded, "…The robotics challenges were quite difficult but even though you had to reset and backtrack a few times, I still had a lot of fun." He is commenting on how even though he had to struggle and try more than once, he was still enjoying himself.

When Evan was asked the same question that made you feel less confident, he said, "When sometimes when we were doing our challenges maybe we came up kind of short when we did them, but we came back and we tried them again and did a little better." Evan mentions trying again to improve during the challenge. He is drawing the conclusion that if you continue your effort, improvement will occur and the challenge will be met. After being asked what happened this week that made you feel more confident, Evan continued "I got better at programming and we completed our challenge."

In many of the interviews, camp participants gave a specific example of how they tried something, failed at it, and then showed success. According to SCCT, students retained high self-efficacy beliefs of "Can I do this?" based on their perceived outcome expectations of "What will happen if I do this?" For example, Satchel said, "it made me feel confident when we were doing Lego robotics because then I knew that I could do stuff since we did it every day, when I did it one day and I did it then I knew could probably do it the next day." In this comment, Satchel is showing that he is learning to persevere and keep trying even when a task is difficult. Hillary seemed to agree with this concept,

> "what … one thing that made me less confident is when me and my partner kept trying and trying and trying to get this piece to fit in and it took us nearly thirty tries, halfway through, my fifteenth try I felt really less confident… what am I doing wrong that's making it not click. But then, after re-evaluating it, I finally soon realized what was going on in it….and the pieces actually fit."

Hillary is referencing here trial and error of programming the robots to complete the challenges. Hillary continues, "Well, I kind of lost confidence when we finally succeeded at our challenge, when we finally made the two pieces connect. When we fixed our problem, that really made me feel really confident."

In other instances, camp participants discussed an overall feeling of continuing on with something where they did not have confidence in their abilities. Javen said, "In robotics it made me feel less confident because we kept getting it wrong, and we kind of gave up for a while. And then we tried again and then it made me feel more confident because after we tried again, it kept working, and almost got it." Students looked to positive expectations even when they felt a lack of confidence.

Many of the new tasks that students attempted lowered their self-efficacy at first because they saw barriers to their success. Some students had no context for working with robotics. When asked what happened this week to make you feel less confident, Annika said, "Well, I went to do robotics and I've never done this before, so it made me not really confident." But there were supports that were put in place by the camp. Because when asked what happened this week to make you feel more confident, Annika stated, "I don't know, maybe there are a lot of factors that go into that, I'd say, the teachers are nice, so that helped a lot." And some students gave examples of complete and total failure before success. Jessica said, "When it came to robotics, when we tried to build an extension thing for one of the motors, what happened was, we ended up nearly destroying the robot, but after a while, we sort of rebuilt everything and completed some of the tasks we needed to do."

Students showed that they knew failure and frustration was part of the process to reach success. For example, Jayden was asked what made you less confident this week, "well the Cats challenge [robotics obstacle challenge course] because the first time I've ever been challenged by any of the challenges which I guess is good, but …that one was … it's pretty rough because it had to be in a very confined set of rules and space." What was interesting is that when asked Jayden's favorite activity, Jayden stated, "I think it was the Cats challenge just because that was the first time that I've ever actually been angered by one of the challenges being difficult." It was interesting that Jayden's most challenging activity was his favorite. This indicates that Jayden enjoyed being pushed out of his comfort zone and learning through adversity. Jayden was asked what made you feel more confident and answered, "Well we're doing the Lego challenge right now, and we completed one of them in less than a minute, which…made me feel pretty good cause most groups took at least twenty to get one of them and we got ours in less than one. It's pretty great and I think we've done six so far." Jayden continued to push himself through timing his team's challenges in order to continue to improve.

Sebastian stated, “That we would fail but then we would achieve what we’re trying to do.” Sebastian also felt as though he knew achievement would eventually be reached and that there seemed to be a process of struggle prior to the achievement. In addition, Kayla notes that “the failure helps to make me better.” Kayla even knew how it made her better. She continues, “Well me and my partner, we kinda had trouble sometimes, and it kinda made us frustrated, but then in the end, it kinda helped us to do better.” Kayla may be suggesting that she is learning that failure is an important part of the process of succeeding. Christian J. said that STEM means “Fun. making mistakes, trying again, and that’s all… yeah, and failing.” Christian J. was very clearly stating that he knew that failing was an integral part of the learning process.

Jenaya said, “In robotics we had to do the UK challenge…it was confusing cause you have to stay inside of the blue, and it’s kind of arched here and I kind of got frustrated.” Not only did students have to follow the guidelines of staying within boundaries, but also had to complete challenges by moving actual obstacles. Jenaya then said, “We had to pick up the blocks to stuff …me and my partner, we got all the way to the yellow, and I was really confident.” Jenaya and her partner were overcoming obstacles by excelling at the robotics challenge during the week.

Sam felt less confident at first this week, “The robotics when I didn’t know… I thought I could build a robot…” and then gained confidence, “once I tried it, I … I did it so I know I could do it”. This ‘never giving up’ language continued to show up in the interview responses. Elliot defined what STEM camp meant to him, “I think it is to have fun and never give up.” The never giving up language was also expanded upon, when Elliot mentioned his career aspirations. He wants to be a firefighter so he can “help people and not give up whenever I …don't do the right thing." Okiki also stated that what happened this week that made her feel more confidence was "never giving up…"

Although I was not present for this year's workshop, I was a volunteer at a previous year's camp. The instructors and camp staff were always encouraging students to continue to work toward their goals. Since the leadership has mostly stayed the same, and the directors of the program continue to train the instructors and staff, it is plausible that the students were echoing the sentiments of "not giving up" emphasized by the instructors, staff and leadership. If confirmed, this would make the connection that the summer program may be helping to alter student thinking about STEM.

There were themes that crossed over with one another. Each assertion seemed to shine through a fragment of a larger camper's response. Camp participants became more confident due to the knowledge of new and different career choices. Jessica's response coupled her self-efficacy beliefs and her future directed career path, "A lot of things that actually it made me feel more confident and the choices that I could make in the future of career choices and things like that. It also made me feel a bit more confident on my robotics, that's it."

Some of camp participant response show how confidence in their abilities to complete a task, challenge or activity eased apprehension or insecurities. When asked what happened this week to make you feel more confident, Motez said, "Just getting comfortable at this camp. Never having been here that's one thing but getting used to being here. In robotics a lot of people have been here over the years so just getting used to this place." Self-efficacy expectations include a person's confidence, or belief that he or she can perform specific behaviors or manage situations. Self-efficacy can be specific and relate to something specific. Miles felt more confident during the week of STEM camp when he was able to accomplish something. He said, “First thing I did was I programmed something that actually worked so that made me pretty confident that I could do it.” Just as self-efficacy is weakened by failures in the same domain, it can also be strengthened through successful experiences in a domain. Miles became more confident when accomplishing one specific task.

Working together with peers and in teams helped students to feel more confidence and ease apprehension. When asked what made you feel more confident, Christian stated, “Helping my partner out with telling him what mistakes he made, mistakes that we made and help my partner in telling him just what to do like rotation and stuff.” Julien’s response also alluded to the power working with others as support, “What made me feel more confident was, I’d have to say…working with my best friend through robotics make me feel a lot more confident because I’m not the best at robotics.” There were not only examples of teamwork within groups to complete a task such as robotics, but times of collaboration in other areas at the informal STEM learning experience. For example, Henry said that what made him feel more confident during the week of STEM camp was “when we were sharing ideas.”

Trends showed that camp participants were aware of cognitive thinking processes focused on problem solving as a significant assertion in the STEM camp. When asked in what ways is STEM camp preparing you for classes you take in school, Evan said, “They get me ready, they thrown you into situations and they show you new things, like things I’ve never seen before, and yea.” Even when it was not evident in the language, Leviticus alluded to having to work out problems using multiple steps and think through problems by saying, “They make use to…to fully use our brain and not to have half-step things.” Joseph stated that problem solving in robotics helped him to feel more confident, “Only that I can probably solved in robotics and everything…problem solving over the other things.” Camp participants could see that each of the challenges and tasks faced in the informal learning experience was a problem to be solved.

Self-efficacy is not fixed; it can be developed. Because we develop our self-efficacy through doing things well (performance), learning from others performance (vicarious experience), being told that we are good at things (verbal persuasion), and feeling good and positive (emotional arousal), some themes tended to overlap.

Problem solving was associated with teamwork and working with peers. Jessica L. added some ideas of teamwork to her problem-solving strategies. She said, “Maybe in STEM at school…I could use the things I’ve learned here…and then...maybe…do something more complex…and help other people if they’re stuck on it. She continues, “Work with…with my partner…Chloe…and…and talking to other group if they could help us if we’re stuck on anything.” Jessica L. was referencing problem solving with her partner. Seeing the benefit of it within her own team, she continued to talk about problem solving with other teams.

4.5 Chapter Summary

The experiences of underrepresented adolescents participating in a 2018 summer STEM robotics camp were analyzed. The research question asked: How does an informal STEM learning experience impact underrepresented minority students’ STEM interest, STEM self-efficacy, and STEM career goals? Utilizing structured interviews, a qualitative analysis of themes was developed. Using structured interviews, the data was compiled into sections, also known as themes or codes (Creswell, 2003, 2007), categorizing data according to consistent phrases, expressions, or ideas that were common among participants (Kvale, 2007). Through the iterative process of coding and thematic analysis, themes were identified associated with each part of the research question. Themes associated with STEM Interest consisted of Engagement and Service. themes associated with STEM Self-Efficacy consisted of Future Thinking, Confidence and Cognitive Thinking. Themes associated with STEM Career Interest consisted of Service and Future Thinking.

CHAPTER 5. DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

5.1 Discussion & Conclusions

The problem addressed by this study is lack of minority representation in STEM fields due to lack of access. The purpose of this qualitative case study was to understand the ways in which an informal STEM learning experience could impact underrepresented minority students' STEM interest, STEM self-efficacy, and STEM career goals. Understanding the role of STEM informal learning experiences in supporting STEM initiatives will provide insight into how students feel supported and how barriers can be removed for underrepresented populations.

A qualitative case study design was chosen for this study to tell the rich stories of participants and for the development of a theory that would help educators understand the role of informal STEM experiences and participating underrepresented minority students. This study was conducted during an informal STEM learning experience and focused on participants recruited for a 2018 summer camp. The qualitative approach allowed me to inductively construct meaning from participant qualitative data (Thorne, 2016). Face-to-face interviews were conducted with 52 participating students who identified as middle school aged minority students according to reported demographic information.

For the purposes of this study, shaping participants' STEM interest, STEM self-efficacy or STEM career goals or related choices denotes the following: finding a fascination or value in STEM; participants' thinking or perceptions about their capabilities in STEM; and engagement of seeking a major or career as a personal goal (Lent et al., 1994).

The results showed the potential development of STEM interest. This could have been attributed to student's self-perceived high performance, positive outcome expectations, and high self-efficacy. STEM interest may also have been affected by personal and contextual/proximal influences as well. Student participants stated they were inspired by parents and/or strong role model in life: they noted a strong role model in their current life that left an impression on their career interest. According to the SCCT, learning experiences, derived from participation in activities can result from the combined influences of personal attributes and environment factors (including parental support, role models, and perceived barriers).

Participants were considered to be engaged and associated STEM with fun and expressed how they found enjoyment in specific activities. An overwhelming amount of student participants expressed they wanted to learn more about those particular topics. Camp participants expressed enjoying learning through hands-on activities. There was also an association of engagement with overall educational learning. Some responses showed an appreciation for the fun activities that were not readily done in their traditional classroom. It is important to note that there was a big discrepancy between the most common theme, Engagement, and the least common theme, Service. It is possible that many more of the student participants were beginning to realize their engagement with activities and experiences at the time of the summer camp. It is plausible that student participants might be able to reflect later on the way they could be of service after completing the summer experience.

The data showed that participants were able to show their interest in STEM by acknowledging how STEM helps the world. Students seemed to begin to see how what was being learned in the informal STEM learning experience could make an impact on others in multiple specific ways.

According to the SCCT, an individuals' interest, particularly in STEM, is directly influenced by the confidence in their ability to succeed in accomplishing tasks (Hardin & Longhurst, 2015). Participant responses showed how confidence in their abilities to complete a task, challenge or activity eased apprehension or insecurities. Students discussed specific activities and situations while also expressing an increase in motivation and belief in themselves to accomplish a task (Bandura, 1986).

In this study, students voiced how overcoming obstacles and easing appreciation during an activity helped them to increase confidence. Camp participants noted how they pushed themselves through difficult challenges and showed perseverance. Many of the students alluded to perseverance and the willingness to be wrong and fail prior to success. Abilities and capabilities are secondary to an individuals' need for self-efficacy when measuring success in STEM fields (Byare-Winston et al., 2010). Participants gave a specific example of how they tried something, failed at it, and then showed success as in this instance.

In some instances, camp participants discussed an overall feeling of continuing on with something where they did not have confidence in their abilities. Students even looked to positive experiences even when they felt a lack of confidence. This could show that students knew failure and frustration was part of the process to reach success. This 'never giving up' language continued to show up in the interview responses.

Problem solving was a perceived benefit of the informal STEM learning experience. Through problem solving challenges, students expressed that they felt as though they had the ability to succeed in other situations due to their ability to succeed in similar future situations. Student outcome expectations seemed to be amplified. Problem solving seemed to be associated with teamwork and working with peers. Student participants expressed that they felt as though they could succeed in situations due to their work with another participant. Working together with peers and in teams helped students to feel more confidence and ease apprehension. These results suggest that engaging students in hands-on and problem-solving activities through peer interaction may be a means of increasing their self-efficacy in STEM disciplines.

When a student can develop high self-efficacy and positive outcome expectations, the student will persist to overcome barriers, and be more likely to have a career in that field (Bandura, 1977; Brown & Lent, 2013). Self-efficacy has been identified as a key factor in persons choosing a STEM career (Tuijl & Molen, 2016). Participants expressed how they perceived the experiences within the STEM camp would impact their future. According to SCCT, one's beliefs about themselves are a strong determining factor of career interest, pursuit and the career realization. Many of the camp participants were able to express in the interviews how they imagine their future self.

Camp participants seemed to understand how the STEM camp was helpful in multiple ways. According to interviews, many participants were introduced to topics where they previously had no experience. Some campers mentioned how the STEM camp could assist in their current traditional school courses. In addition to expressing how the topics and activities in the summer program differed as compared to their traditional school courses, participants noted there was a different quality of learning within the informal STEM learning experience.

According to SCCT, self-efficacy influences interest in STEM and STEM career goals (Brown, 2002), and the choices that people make and the actions that people take that are related to those choices are influenced by their interests (Lent, Brown, & Hackett, 1994). Imagining themselves and their impact on the future, camp participants expressed a desire for significance in begin service oriented. Even when camp participants did not know exactly what they wanted to be, they still desired to do something important, of significance, that was helpful to others and to contribute to world through STEM.

5.2 Implications

This study supports the assertion within Social Cognitive Career Theory that when students have high self-efficacy and positive outcome expectations, they tend to develop interest in an activity, and subsequent goals that increases involvement in the activity (Brown & Lent, 2013). Underrepresented minority students attending the informal STEM learning experience were afforded a contextual influence that supported students in the form of equity and access. This proximal influence impacted student STEM interest, and STEM career goals. Acting as a moderator, the equity and access provided to underrepresented minorities amplified student STEM self-efficacy. According to Social Cognitive Theory, there is a likelihood that one’s goals can impact actions, and that interest can affect and/or impact goals.

A final aspect that emerged from the data, was that the primary needs of the student participants were being met by summer program; participants enjoyed the food/nutrition they were provided during the experience. For some of the students, this was their favorite aspect. During the summer, school meal programs are not readily available to public school children. It is possible that the STEM program improved opportunity and access for students by removing the barrier that can exist when students' primary needs are not met.

Through the reading and rereading of the transcripts, the voices of the student participants came alive. Based on the study's findings and those voices, there are recommendations I would make to someone who wanted to design a STEM camp. As I stated, staff, instructors, and camp leadership were always encouraging students to continue to work toward their goals during the workshops, and students seemed to be echoing the sentiments of "not giving up" emphasized while they were grappling with challenges. The connection is that summer program may be helping to alter student thinking about STEM. These implications of altering student thinking might transfer to K-12 schooling to support minority students' interest in STEM.

5.3 Future Research Directions

Through this study, I can see the need for not only increasing access of informal STEM learning experiences for underrepresented minority student, but also increasing the diversity of those experiences. Because of my career experiences in formal and informal STEM opportunities, I can also see the need to create connections and coherence between formal and informal STEM learning experiences that not only begin in early childhood education but that stay consistent throughout middle and high/secondary school. For example, a research question that should be asked would be how do informal STEM learning experiences affect formal learning experiences for student interest, self-efficacy and career intentions.

5.4 Chapter Summary

The results showed the development of STEM interest. Participants associated STEM with fun, expressed how they found enjoyment in specific activities, and acknowledged how STEM helps the world. Participant responses show how confidence eased apprehension or insecurities, and pushed themselves through difficult challenges, showing perseverance. Students knew failure and frustration was part of the process to reach success. Problem solving was a perceived benefit of the informal STEM learning experience, and was associated with teamwork, resulting in increased confidence and ease apprehension. Participants perceived the experiences within the STEM camp as impactful to their future and imagined their future self. Camp participants stated how the STEM camp was helpful, were introduced to topics where they previously had no experience and had a desire for significance and being service-oriented. Students expressed how the experience helped in their current traditional school courses, while noting there was a different quality of learning within the informal STEM learning experience.

There continues to be a need for increasing access of informal STEM learning experiences for underrepresented minority students, and increasing the diversity of those experiences, in addition to creating connections and coherence between formal and informal STEM learning experiences beginning in early childhood education throughout middle and high/secondary school.

APPENDIX A. STUDENT INTERVIEW PROTOCOL

1. Other than the 4 words – Science, Technology, Engineering, and Mathematics – What does STEM mean to you?
2. What do you want to be when you grow up? Why are you interested in becoming ____________? Are you interested in any STEM careers?
3. If you could solve any problem in the world today, what would it be and why? Have you thought about how you might solve it? How might you use STEM to solve it?
4. In what ways is STEM Camp preparing you for the classes you take in school?
5. What happened this week to make you feel less confident? Why?
6. What happened this week to make you feel more confident? Why?
7. What have you enjoyed about STEM Camp so far? Why?

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B.A.	Department of Communication, Media and Languages College of Arts, Humanities, and Social Sciences Morehead State University, Morehead, KY (2000)

PROFESSIONAL EXPERIENCE

2020 - present	Instructor/Craft QEP Director Craft Academy for Excellence in Science & Mathematics Morehead State University
2018 - 2020	Research/Project Manager Craft Academy for Excellence in Science & Mathematics Morehead State University
2012 - 2018	Professional Development Associate 21st Century Education Enterprise, College of Education Morehead State University
2003 - 2012	Science (Biology, Integrated Science, AP Bio) Teacher, High School, Mason County School District

SCHOLASTIC & PROFESSIONAL HONORS

PAEMST Presidential Awards for Excellence in Mathematics & Science Teaching, Kentucky Reviewer: Middle and High School, 2015-2022
Light It Up! Camp for Engineering, Entrepreneurship & Innovation, 2019
SpaceTrek Camp for Young Women in Space Science, Detail Specialist, 2018-2019
Hiring Committee – Asst. Director of Counseling Services, Morehead State, 2018
Morehead State University *Blast Off* Camp, Staff, 2018
Hiring Committee - Office Manager, Morehead State University, 2016
Kentucky Science Leadership Network, Science Teacher Coach, 2014-2016
University of Kentucky STEM Teacher Leader Panel Discussion, 2015
STEM Robotics Teacher Leader, University of Kentucky See Blue™ STEM Camp, 2015
Teaching Mentor & Support Provider, National Board for Professional Teaching Standards® (NBPTS), 2014-2015
Craft Academy Cedar, Inc.: ECLRP (Entrepreneurial Coal Land's Redevelopment Project) Administrative Mentor, 2018-2021
Craft Solar Car Challenge Administrative Mentor, 2021
Craft Science Olympiad Administrative Mentor, 2021
MoSU Undergraduate Research Celebration of Student Scholarship Council, 2019-2020
MoSU Undergraduate Research Celebration of Student Scholarship Judge, 2019-2020
Craft FIRST® Robotics Administrative Mentor, 2018-2020
Craft Academy Research Student Mentor, 2018-2019
Morehead State University Celebration of Student Scholarship Judge, 2018-2019
Morehead State University Undergraduate Research Student Mentor, 2014-2015
Morehead State University Craft Academy ACT Prep Facilitator, 2016
MSU Craft Academy Athletic Dept. Scavenger Hunt Designer, 2016
Morehead State University Governor's Scholar Program Presenter, 2013
Morehead State University MAT Technology Competencies Presenter, 2013
KAGE Kentucky Association for Gifted Education, 2019-2021
KySTE Kentucky Society for Technology in Education, 2012-2019
SSMA School Science and Mathematics Association, 2017
NSTA National Science Teachers Association, 2015-2017
ISTE International Society for Technology in Education, 2014-2017
KSTA Kentucky Science Teachers Association, 2012-2017
Commonwealth of Kentucky Colonel, 2016-present