A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants

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ABSTRACT

The *Every Student Succeeds Act of 2015* implores educators to increase female access to and involvement in Science, Technology, Engineering, and Mathematics (STEM) programs in order to improve the diversity of the STEM workforce. Within the literature, it is suggested females who have access to pre-collegiate STEM opportunities are more likely to matriculate in collegiate STEM degree programs. This phenomenological study evaluated the experiences of five female college students who participated in a Student Lab Assistant Research Program (LAB) during high school. To elicit information about the impact of the LAB on female students' beliefs and interests in STEM, each student engaged in interviews following Seidman's three-interview series framework. Data was coded and analyzed using Moustakas' modification of the Stevick-Colaizzi-Keen Method of Analysis of Phenomenological Data. Analysis of data resulted in two core themes emerging as impactful components of the LAB including active learning with real world applications and opportunities for skills acquisition and influential relationships altering perceptions and science attitudes. Findings align with environmental, behavioral, and personal variables known to positively affect choice behaviors as described by Lent, Brown, and Hackett's Social Cognitive Career Theory. Participation in the LAB positively contributed to female students' choice to major in STEM degree programs in college. This study offers suggestions for implementation of the LAB in a traditional high school setting. Further research is needed on the lasting impact of the LAB and other pre-collegiate STEM opportunities as viable nontraditional science programs with potential to plumb the leaky STEM pipeline.

Keywords: choice, female, high school, matriculation, phenomenological, pre-collegiate, programs, qualitative, science, secondary, Social Cognitive Career Theory, STEM, STEM pipeline

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Finally, to the LAB girls who are a source of inspiration. You are the future of STEM and the future is bright! Working with you has helped me grow as an educator and as a person. Your dedication, generous spirits, and open hearts are the catalyst for change needed for perceptions of women in STEM to change.

> The greatest achievement of the human spirit is to live up to one’s opportunities and make the most of one’s resources. ~ *Marquis De Vauvenargues*

DEDICATION

To
Leslie Ann Corbin
My nana
For instilling in me a love of learning and encouraging me to dream big and work hard.
This would not have been possible without the foundation you provided me. Thank you!
and
Christopher Bryan Cantrell
My husband
All things are truly possible with the love, support, reassurance, and friendship you continually demonstrate. Your unwavering belief in me is humbling and inspirational. Thank you for your patience and understanding during this journey. I am blessed beyond measure to have you as my partner. You are my heart!
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You have been my source of sanity during this process. Your endless encouragement helped me persist when it would have been much easier to quit. Your shoulders were needed and appreciated. Knowing you inspires me every day to be the best I can be. I hope this process shows you the importance of perseverance and I hope to repay the favor one day. You make me so proud and I love you so much!
Well-behaved women seldom make history. ~ *Laurel Thatcher Ulrich*

Chapter I

INTRODUCTION

College majors are not found in blue and pink aisles, but some might as well be. Forty years ago, 75% of students studying to be elementary teachers were female. Today, 90% are female. Teaching is getting pinker. Only one in five engineers is female, two-thirds of physics majors are male, and a lower percentage of females is studying computer science today than a decade ago. These are blue majors. Even when women break free of gender stereotypes, as they have in many math and science courses, too few actually find careers in science or math (Sadker, Sadker, & Zittleman, 2009, p. 2).

Overview

The purpose of this study is to understand the perceived impact of the Student Lab Assistant Research Program (LAB, a pseudonym) on female lab assistant students' interests and beliefs about Science, Technology, Engineering and Mathematics (STEM) at Franklin High School (FHS, a pseudonym). Specifically, I aim to examine the impact of the LAB, a pre-collegiate STEM opportunity, on female lab assistants who have participated in the program for at least two academic semesters by providing a systematic way to explore their lived experiences. In this chapter, I will examine the background of the problem, which is a lack of female involvement in STEM at the national and global level, as well as introduce the research questions that will guide the study (Dasgupta & Stout, 2014).

Background

The future is STEM (National Science Board [NSB], 2015; Next Generation Science Standards [NGSS], 2017; Vilorio, 2014; White House, 2010). The STEM workforce is critical to innovation and competiveness at the global level (NSB, 2015; NSB, 2016; National Science Foundation [NSF], 2017). To safeguard U.S. competitiveness, our nation must foster "strong, STEM capable" individuals by ensuring all individuals have access to comprehensive, high quality STEM education (NSB, 2015; NSB; 2016; NGSS, 2017). Science and science education are critical to the lives of all Americans (NGSS, 2017). Comprehensive science education guarantees students develop an in-depth understanding of not only content but also skills such as communication, collaboration, inquiry, and problem solving (NGSS, 2017). Science, technology, engineering, and mathematics minded people are imperative to global prosperity in the 21st century; innovation, creativity, and tenacity of STEM professionals drive global culture and economy (NSB, 2015; NSB, 2016; NGSS, 2017; Taylor, 2015; White House, 2010).

The Office of Occupational Statistics and Employment Projections within the U.S. Bureau of Labor Statistics reported that between 2012 and 2022, STEM careers will have faster than average growth in almost all STEM areas (Vilorio, 2014). Estimates by the U.S. Department of Commerce (2011) reported STEM jobs were projected to grow 17% by 2018 as compared to other non-STEM related jobs which were only projected to grow by approximately 10%. Recent estimates show an overall increase of 14% from 2010-2020, but areas such as biomedical engineering, medical science, software development, and computer analysis are seeing growth increases of 62, 36, 32 and 22%

respectively (U. S. Department of Education, 2015). Employment in overall STEM occupations increased 10.5% from May 2009 to May 2015, contributing nearly 818,000 new jobs while mathematical science occupations are projected to grow from 2014 to 2024 at an increase of 28.2% followed by computer occupations, which are projected to increase 12.5% from 2014 to 2024 (Fayer, Lacey, & Watson, 2017). Over 800,000 net STEM jobs were added to the U. S. economy between May 2009 and May 2015. Employment changes in Georgia alone for STEM occupations from May 2009 to May 2015 were greater than 24,651 or 15.7% (Fayer, Lacey, & Watson, 2017). There is a need for qualified people to fill these roles. Collectively, the nation is facing an increasing skills gap in STEM, whereby highly skilled jobs in STEM fields are going unfilled or going to foreign workers due to a shortage of U.S. workers who are qualified to fill these positions (Evans, McKenna, & Schulte, 2013).

Economic projections point to a need for over 1 million qualified STEM professionals in order to meet the ever growing demands of industry (President's Council of Advisors on Science and Technology [PCAST], 2012; Tanenbaum, 2016; Vilorio, 2014), while the Committee on Science, Engineering, and Public Policy (COSEPUP) attributes approximately 85% of measured growth in income in the United States to technological change (COSEPUP, 2007). Tanenbaum (2016) substantiates these findings by stating major U. S. companies will need 1.6 million STEM-skilled employees in the next five years with cognitive knowledge, skills, and abilities associated with a STEM education. The NSB (2015) explains the "size and complexity of the STEM workforce has grown by leaps and bounds as science and technology have come to touch many corners of our economy," supporting a need to address STEM education reform. The

United States has persistent inequalities in "access, participation, and success in STEM subjects" across gender, socioeconomic, and racial lines (Tanenbaum, 2016). Closing education gaps by addressing STEM education disparities is imperative if the nation is going to keep up with technological change (Tanenbaum, 2016). Over a decade ago, COSEPUP (2007) stressed the importance of an increased focus on STEM education as "the domestic and world economics depends more and more on science and engineering [but] our primary and secondary schools do not seem to be able to produce enough students with the interest, motivation, knowledge, and skills they will need to compete and prosper in the emerging world" (p. 94). The nation continues to have a shortage of STEM qualified individuals. The need for a STEM workforce is critical, extensive, and necessary for continued global competitiveness (NSB, 2015).

STEM Forecasts

According to the U.S. Department of Commerce (2011) STEM drives the workforce, yet projected a shortage of qualified individuals to fill an increasing number of positions in STEM fields. A particular concern is the underrepresentation of females in the STEM workforce. While the number of females in the workforce totals 57.2% (U.S. Bureau of Labor Statistics, 2014), there is an underrepresentation of females in STEM fields (Dean & Kloster, 2014; Van Miegro & Glass, 2017). According to the U.S. Department of Commerce, only 24% of jobs in STEM-related occupations were held by females as of 2009 (Beede et al., 2011). In a recent *Educate to Innovate* release, former President Obama stated "we simply cannot, as a Nation, expect to maintain our run of ingenuity and innovation—we cannot maintain that stream of new and different ideas—if we do not broaden participation in STEM to *all* Americans, including women and girls and minorities" (White House, 2015). Nationwide, only 24% of all STEM jobs are held by females (Noonan, 2017).

The *Every Student Succeeds Act of 2015* charges educators with increasing access to and the number of females involved in STEM in order to improve the diversity of the STEM workforce (SCHELP, 2015). In a study comprised of 1.8 million students, only 293,306 (16.3%) had an expressed and measured interest in STEM, which is a decrease in the number of students who expressed interest previously (Erickson, 2016). Growth in the number of females choosing collegiate STEM majors could narrow the aforementioned gap. In this effort, it is imperative that effective and cost-efficient ways to increase female interest and participation in STEM programs are identified.

The American Association for the Advancement of Science (2015) stated that despite a 1.2-billion-dollar yearly budget for K-12 STEM education, the United States continues to flounder in global performance rankings in mathematics and science. Recent statistics from the Program for International Student Assessment [PISA] (2012) reported that 22 international education systems outperformed the United States in science and mathematics by a statistically significant margin (Organization for Economic Cooperation and Development [OECD], 2012), which is an increase of 4 international education systems since 2009 (National Public Radio, 2015). While the United States spends more money per student than other leading countries, the increased spending is not translating into increased interest or performance in STEM. U.S. students were particularly weak in practical application of mathematics and science content (PISA, 2012). The choice by students to purse STEM degree majors is made in high school (Maltese & Tai, 2011; Sadler, Sonnert, Hazari, & Tai, 2012), so if the United States aims to remain globally competitive in STEM research and commerce, educational programs must be implemented in high schools that offer more authentic STEM experiences (Brown, 2016; Maltese & Tai, 2011; Vilorio, 2014).

Traditionally, science coursework has been hands-off, teacher centered, and science literacy has not been a priority (Dillion, 2016). In the recent past; however, legislation has necessitated a shift from traditional STEM education to a model that serves all students through the use of student centered hands-on instruction that provides opportunities for real world application and supplementary STEM experiences (Senate Committee on Health, Education, Labor, and Pensions [SCHELP], 2015.) Former President Barack Obama stated "[Science] is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world . . ." (U.S. Department of Education, 2015). While success in STEM requires in depth knowledge of one's field, it is also imperative that individuals be able to apply this information in a practical way (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013). Traditional programs do not adequately prepare our young people for success in collegiate degree programs in STEM (Taylor, 2015). To provide students with a STEM education that appropriately prepares them to meet the demands of STEM careers, it is imperative that students have access to science labs and equipment to conduct investigations and complete activities that reflect real world applications of the curriculum. Moreover, students need opportunities to analyze experimental data in meaningful ways that model practical application in potential real world scenarios. Educators and science curricula need to offer opportunities in STEM that exceed the boundaries of the typical classroom experience (Taylor, 2015). Reform initiatives for STEM argue a need to shift from teaching students to memorize facts and skills to applying those skills in real world settings; to initiate learning experiences allowing learners to engage, inquire, problem solve, and think critically (Asghar, Ellington, Rice, Johnson, & Prime, 2012; Bailey, Kaufman, & Subotic, 2015; Betrus, 2015). Students need opportunities to explore STEM in a way that integrates content and process in order to initiate legitimate interest (Kennedy & Odell, 2014). Hands-on experiences reinforce academic content but also allow students to gain soft skills such as collaboration, problem solving, and teamwork, as well as programs that focus on innovation, invention, and problem-based learning are imperative to STEM curriculum (Kennedy & Odell, 2014; Taylor, 2015). Exploration of innovative pre-collegiate programs that offer a viable supplement to a traditional science curriculum is crucial to increasing female matriculation into collegiate STEM degree programs as early exposure is linked to female enrollment and persistence in STEM (Cano, Koppel, Gibbons, & Kimmel, 2004; Edzie, Alahmad, & Alahmad, 2015).

Despite a call for STEM reform, the percentage of students who are motivated by in-school and out-of-school STEM experiences to pursue careers in these fields is too low (Gauch, 2012) and students disengage in STEM coursework beyond compulsory schooling at a high rate (Bell, 2016). Proportionally, more females than males left STEM degree programs in college by switching to a non-STEM major (32% vs. 26%) suggesting that high schools do not adequately prepare females for collegiate STEM programs (Chen, 2013). Additionally, females who do persist in STEM attribute matriculation to factors beyond increased exposure and hands-on experiences including the opportunity to engage in learning that is connected to personal interests and the ability to form social and professional connections with peers and mentors (Nugent, Barker, Grandgenett, & Adanchuk, 2010). Subsequently, female students need access to programs that take into account self-confidence in STEM as a lack of self-confidence in STEM abilities has been linked to female attrition (Rittmayer & Beier, 2008, 2009).

Statement of the Problem

Despite the increased demand for STEM professionals, the number of people seeking degree programs in STEM and entering STEM fields is not high enough to fill the demand for STEM qualified individuals in the workplace (Evans, McKenna, & Schulte, 2013; PCAST, 2012). While females could help close this gap, they continue to be underrepresented in STEM fields (Beede et al., 2011; Dasgupta & Stout, 2014; Phillips, 2017). There is a lack of non-traditional coursework as well as a lack of pre-collegiate STEM opportunities within the school day compounded by a lack of science curriculum that properly prepares females for STEM courses at the collegiate level by offering pre-collegiate research exposure and continued engaging, individualized, and real world content (Edzie, Alahmad, & Alahmad, 2015; Taylor, 2015). Finally, traditional pre-collegiate and collegiate coursework often lacks the mentoring relationships that literature has shown to impact the matriculation of females in STEM (Bottia, Stearns, Mickelson, Moller, & Valentino, 2015; Cutright & Evans, 2016; Maltese & Tai, 2011). While characteristics of successful STEM programs have been identified and a wealth of literature on effective science curricula exists, there are few studies that report on pre-collegiate STEM opportunities within the school day and no studies report on the impact of student lab assistant research programs (NRC, 2012; Sanders, 2008; Taylor, 2015;

U.S. Department of Education, 2015). In this study, I will explore how female lab assistants think their beliefs about and interests in STEM have been impacted by their participation in the LAB at FHS.

Purpose of the Study

The purpose of this qualitative study is to explore the lived experiences of female students who participated in the LAB at FHS to (a) identify the impact it has on their beliefs and interests in STEM and (b) create a platform to explore the perceptions and thoughts of high school students necessary for a thorough evaluation of the student lab assistant program which could provide new teaching methodologies for pre-collegiate STEM programs. Many researchers focus on quantitative data about self-efficacy and attrition rates of female students in STEM programs reporting statistical findings only, but this study will address the problem qualitatively to gain a more holistic and comprehensive perspective about the perceptions of female students regarding their experiences in a pre-collegiate STEM program to add to the existing literature.

I seek to learn more about the LAB and increase my understanding of the factors in this pre-collegiate STEM program that contributed to the perceived impactful experiences students had that lead to matriculation in STEM programs. The research questions that guide this study are as follows:

1. What are the perceptions of female lab aides about the impact of participating in LAB on their beliefs and interests in STEM?
2. What do female lab aides perceive as LAB elements most beneficial to their beliefs and interests in STEM? What elements are the least helpful?

2A. What do female lab aides suggest to improve the LAB and, perhaps, to increase the number of female students interested in collegiate STEM majors?

Significance of the Study

In *A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas*, the National Research Council (2012) pointed out that while existing research documents developed in the early to mid-1990s laid a foundation for science education, there is much room for improvement in research in the areas of learning and teaching science. Close to two decades ago, Olson and Loucks-Horsley (2000) stated, "All students, not just those destined for a scientific, technical, or health-related career, can benefit from the skills that science education can provide—such as critical thinking, data analysis, working in teams, and oral and written communication" (p. 1). Gauch (2012) further developed this claim by saying, "The understanding of, and interest in, science and engineering that its citizens bring to bear in their personal and civic decision making is critical to good decisions about the nation's future" (p. 242). Findings from more recent studies reiterate the importance of thinking and problem solving skills acquisition as well as real world application of scientific skills in science education (Clausen & Greenhaigh, 2017). Moreover, the *Every Student Succeeds Act of 2015* calls for greater access to STEM content, and the integration of classroom based and afterschool and informal STEM instruction as well as the expansion of environmental education (SCHELP, 2015).

In this study, I investigated a pre-collegiate STEM program that offered female students increased exposure to STEM within the school day. The lab assistant research program fostered an environment of collegiality where female students' motivation to learn was high, which allowed for learning connected to personal interests (Nugent et al., 2010; Wang, 2012). The LAB also facilitated building social and professional connections with peers and mentors, which may have led to an increase in self-efficacy by helping females develop new skills that emphasized ingenuity, innovation, and higher order thinking skills (Nugent et al., 2010). Rittmayer and Beier (2008) identified a lack of self-confidence in high school females regarding science and mathematics as a contributor to the gender gap in STEM professions. Rittmayer and Beier (2009) suggest a need for programs that build the confidence of high school females by providing extended exposure to STEM to encourage the selection of collegiate STEM degree programs. The ultimate goal is to eliminate the gender gap in STEM professions.

Through this study, I aim to provide insight about the impact of participating in a high school lab assistant program on female high school students interests and beliefs about STEM by sharing the lived experiences of the participants. An effort will be made to assess which components of the LAB program are most and least beneficial in terms of interest and beliefs about STEM. Finally, I will report on improvements to the LAB program as suggested by the participants. If study findings indicate a relationship between increased interest in STEM and collegiate STEM degree programs, these findings could be used by science educators seeking to implement programs that promote greater female involvement in STEM during the school day thus eliminating the gender gap in STEM professions. The findings of this study could inform educators and policy makers about additional high school STEM opportunities for females which addresses the National Agenda from federal agencies such as PCAST, the National Science Foundation, and the National Research Council to increase the number of females in

STEM programs (Britt, 2011; NRC, 2009, 2011, 2012, 2015; NSF, 2017; Olson & Riordan, 2012; PCAST, 2012).

Key Terminology

The following definitions are applicable to this study:

Collegiate. Post-K-12 education.

Contextual Variables. Factors that contribute to the social aspects of females' interest and pursuit of careers in STEM fields.

Experimentation: For the purposes of this study, this means scientific investigations

LAB. Student Lab Assistant Research Program.

Lab aide/assistant. A person who works as a part of a student lab assistant research program fulfilling duties assigned to them, such as researching, setting up, or dismantling life and physical science labs.

Personal Variables. Factors that contribute to the cognitive aspects of females' interest and pursuit of careers in STEM fields.

Pre-collegiate. Having taken place before enrollment in an undergraduate degree program.

Pre-collegiate STEM activities. For the purposes of this study, this means any program that enhances knowledge, understanding, and practice of science, technology, engineering and/or mathematics to students before entering an undergraduate degree program.

Real world application: For the purposes of this study, this means conducting activities that are science related, require the use of scientific practices, and necessitate the application of scientific skills.

Self-efficacy. Defined as one's belief in one's ability to succeed in specific situations or accomplish a task; judgment about one's ability to organize and execute the courses of action necessary to attain a specific goal (Bandura, 1977, 1997).

STEM. Pertaining to science, technology, engineering, and mathematics. For the purpose of this study, the focus is on the "S" for science.

STEM major. For the purposes of this study is any undergraduate degree program in science, technology, engineering, or mathematics.

Chapter II

REVIEW OF LITERATURE

Here's how my high school chemistry class was taught: Boys were seated by the male teacher on the side of the room with the teacher's desk. Girls were seated on the far side of the room. Girls were told to be quiet and not to cause trouble and they would not fail the class. When "dangerous" experiments were conducted, the boys went into the lab while the girls watched through a window (Sadker, Sadker, & Zittleman, 2009, p. 49).

Introduction

To date, there are no existing studies that provide an analysis of the impact of a lab assistant research program on the female participants in it. In this chapter I will present extant literature on STEM programs and identify characteristics of programs shown to influence female persistence in STEM.

This literature review is organized in the following manner: (a) the need for more STEM majors, (b) existing STEM programs, (c) characteristics of effective STEM programs, and (d) the theoretical concepts that frame this study.

Need for More STEM Graduates

High attrition rates of females in collegiate STEM degree programs and STEM careers continue to be an issue in our current education system. In order to increase female matriculation through STEM degree programs and in STEM careers, STEM program coordinators need to consider variables that positively impact female learners (Edzie, Alahmad, & Alahmad, 2015). Social Cognitive Theory and Social Cognitive

Career Theory indicate individual choices are influenced by meaningful exposure. Meaningful exposure to STEM programs informs choice decisions about collegiate STEM degree programs and STEM career choices (Edzie, Alahmad, & Alahmad, 2015).

Meaningful Exposure

Researchers report that meaningful STEM exposure includes learning communities (Carrino & Gerace, 2016; Graham et al., 2013; Mayer, Christoffersen, & Fiorella, 2017). Camps and after-school programs, as well as research-based work, including individual and group lab work, science camps, and workshops have also been identified as meaningful STEM exposure (Dabney et al., 2012; Dasgupta & Stout, 2014; Kong, Dabney, & Tai, 2014; Sahin, Ayar, & Adiglezal, 2014).

STEM Program Characteristics

A myriad of variables are presented in the literature that identify the characteristics of effective STEM programs, among which mentoring and female role models are shown to have a strong positive relationship regarding the matriculation of females in STEM programs (Bottia et al., 2015; Cutright & Evan, 2016). Project-based learning which offers hands-on science experiences is also reported as meaningful exposure (Scutt, Gilmartin, Sheppard, & Brunhaver, 2013). Additionally, STEM programs that focus on individualized education significantly increase the engagement of participants (PCAST, 2012), and an emphasis on soft skills acquisition broadens participation in STEM programs and thus STEM careers (Darling & Dannels, 2003; Dasgupta & Stout, 2014). Active learning and incorporating real world experiences rank among the most significant contributors to effective STEM programs (Capraro, Bicer, Grant, & Lincoln, 2017; Dasgupta & Stout, 2014; PCAST, 2012). When personal factors (see Figure 1) such as self-perception, stereotyping and gender bias, and self-doubt/self-confidence are taken into account, retention of female students in STEM increases (American Association of University Women [AAUW], 2010; AWS, 2016; Shumow & Schmidt, 2013a, 2013b; Thoman & Sansone, 2016).

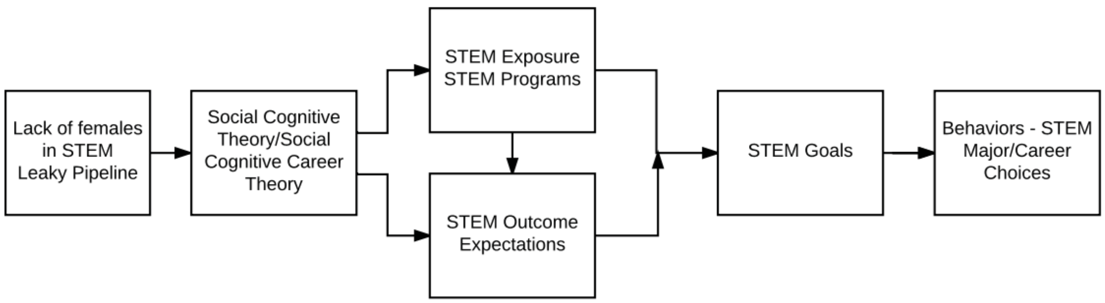

Figure 1. Factors influencing female students' persistence in collegiate STEM degree programs. This figure illustrates the need to offer more STEM learning experiences to female high school students.

While not only is there a "leaky pipeline" in STEM, some would argue that the plumbing system itself is broken (Samarasinghe, 2017). Females currently earn 58% of all bachelor's degrees awarded in the United States (United States Department of Education, 2012), yet only 25% of all STEM jobs are held by females (United States Department of Education, 2012). Researchers who conducted a two-part analysis study to assess school-based practices that lead to STEM choice indicated that STEM choice is made in high school and that exposure, not enrollment or achievement, has the greatest ability to plumb the leaky pipe (Maltese & Tai, 2011). The dissonance in the number of females who achieve in STEM programs and those who choose to pursue STEM careers may be mitigated by "sympathetic teachers" in pre-collegiate educational STEM programs (Takruri-Rizk, Jensen, & Booth, 2008) who, according to Clark Blickenstaff, will "help women break down the filter in the STEM pipeline and result in equal participation, which will be good for STEM and good for society in the long term" (2005, p.384).

Not enough U.S. students have equal access to or interest in STEM (U.S. Department of Education, 2015). By addressing the gender gap that exists in STEM and getting more females STEM ready, society could begin to bridge the gap and help students build the life skills necessary to succeed in the 21st century (Taylor, 2015). This can be accomplished by offering more pre-collegiate STEM learning experiences that promote both awareness of and interest in STEM collegiate degree programs and careers. A successful STEM program must consider environmental factors such as exposure to different learning environments and STEM programs, which contribute to meaningful exposure, as well as personal variables such as social persuasion, gender stereotypes, and self-perceptions (AAUW, 2010; AWS, 2016; Correll, 2001; Correll, 2004; Dasgupta & Stout, 2014; Kahle et al., 1993; Young, Ortiz, & Young, 2017).

To address the gender disparity in STEM, the *Educate to Innovate* campaign was launched, which focused on the promotion of STEM education in underrepresented groups including female students (White House, 2015). Moreover, the AAUW (2010) revealed a need to expose female students to more STEM opportunities and provide more female role models in STEM. Study findings indicate exposure to role models can help reduce negative gender stereotypes surrounding female competency in mathematics and science. Additionally, pre-collegiate STEM opportunities that focused on individualized learning and relationship building showed significant contributions to STEM matriculation for female students (NRC, 2011; Nugent et al., 2010). Furthermore, increased motivation, engagement, and pre-collegiate exposure to STEM significantly influenced female students' self-efficacy in mathematics and science, which in turn encouraged their choice to pursue a career in STEM (Britt, 2011; NRC, 2011; National Math and Science Initiative [NMSI], 2016). Young female students have formed ideas about potential collegiate STEM degree programs upon reaching high school (Clark Blickenstaff, 2005; Novakovic & Fouad, 2013) which necessitates the offering of opportunities for pre-collegiate STEM learning experiences that positively impact high school females.

Existing STEM Programs

Alternative STEM education programs have been shown to increase motivation and engagement in STEM activities (NMSI, 2016; Wang, 2012). While alternative STEM educational programs have long been the subject of research and have been found to increase student achievement in STEM, the U.S. educational system still trends towards the traditional school model (Burke & McNeill, 2011)–a model that has been shown to encourage a leaky STEM pipeline. If we are to remain globally competitive, it is imperative that we investigate STEM programs outside the traditional classroom setting (Dabney et al., 2012; Dasgupta & Stout, 2014; Freeman, Marginson, & Tytler, 2015; Kong, Dabney, & Tai, 2014; Sahin, Ayar, & Adiglezal, 2014). Over and above, students involved in STEM clubs, after-school activities, and science fairs outperformed their noninvolved counterparts (Sahin, 2013). A Texas charter school reported students involved in STEM after-school clubs have a higher matriculation in STEM majors than the national average at 65% and 33% respectively (Sahin, 2013). Among the data, involved female students ranked at 51% matriculation over the national average of 15% (Sahin, 2013).

A crucial component in the retention of females in STEM is access to meaningful science experiences outside of traditional curricula, including pre-collegiate STEM opportunities. Edzie, Alahmad and Alahmad (2015), reported that pre-collegiate STEM exposure greatly influences female enrollment and persistence in STEM programs. Reported findings from surveys and focus group interview data suggest early exposure to STEM programs which emphasize active learning help plug the leaky pipeline (Graham et al., 2013; Johnson & Johnson, 2016). Traditionally, pre-collegiate programs are offered before or after school, on weekends, or during the summer and/or have expensive price tags, limiting the number of individuals who can take advantage of these opportunities (Dabney et al., 2012; Graham et al., 2013; Sahin, 2013). The short duration of most programs, along with a lack of concrete data and reports of evaluation, suggest a need to offer more diverse opportunities for meaningful STEM exposure to students (Cano et al., 2004; Dasgupta & Stout, 2014). Meaningful STEM exposure includes learning communities (Mayer et al., 2017), camps and after-school programs (Sahin, Ayar, & Adiglezal, 2014), as well as hands-on, inquiry-based work (Dabney et al., 2012). An examination of current pre-collegiate STEM opportunities, which include targeted STEM programs that are part of school curricula or act as learning enrichment opportunities in STEM disciplines, is needed in order to explore the LAB as a viable pre-collegiate STEM opportunity for female high school students.

Learning Communities

A study done by Mayer, Christoffersen and Fiorella (2017) indicated great success with a Biomentors group, a learning community at a university aimed at increasing STEM program matriculation. Participants in the study significantly outscored participants in the control group when variables of gender, grade point average, and standardized test scores were controlled. The finding of this study suggests a need for effective learning communities and mentorship programs. In another study done by Graham et al. (2013), learning communities were identified as important because they offered opportunities for intellectual growth and involvement with other aspiring scientists. Researchers suggested cultural minority groups are less likely to form learning communities on their own and need direction to form inclusive groups, which can be done with the assistance of an instructor (Graham et al., 2013).

The WISE (Women in Science and Engineering) Learning Community was implemented at Grand Valley State University to offer opportunities for increased exposure to STEM and peer mentorship, including "a supportive, conducive, and relaxed atmosphere with fellow female students and female role models in the sciences" (Morgan, 2013, "Case Study," para. 5). It was hypothesized that the WISE program would lead to increased confidence in abilities, increased retention rates, higher involvement and confidence as well as a greater sense of belonging. A case study analysis was performed, and student data supported the initial hypotheses about WISE; the female university students surveyed reported increased confidence and enjoyment (Morgan, 2013). Carrino and Gerace (2016) argue learning communities facilitate student academic success in STEM and persistence in STEM degree programs. This argument is based on data gathered in a case study of a STEM based learning community, where students conveyed a belief in their ability to be successful, felt increased social and academic engagement, and better self-identified as a scientist or as a member of a STEM profession as a result of being a part of a learning community. Students, especially female students, are likely to form enduring interests in a program when they see themselves as successful members of a community (Kuh, Kenzie, Buckley, Bridges, & Hayek, 2006). Morgan's (2013) and Carrino and Gerace's (2016) study findings support learning communities as a strategy for female persistence in STEM degree programs.

STEM Camps, Clubs, and After-School Programs

Camps, clubs, and after-school programs provide extracurricular exposure to STEM to the students who choose to participate in them. Students who participate in STEM summer camp experiences in middle school are more likely to report interest in STEM as compared to students who did not participate in pre-collegiate STEM programs (Dabney et al., 2012; Kong, Dabney, & Tai, 2014). While the duration of participation in pre-collegiate STEM programs does not appear to be a significant factor in STEM interest, findings from a study conducted by Young, Ortiz, and Young, (2017) reported "the focus of the program was a significant moderator" indicating exposure was crucial to interest in STEM. Moreover, creating informal STEM learning environments, STEM-based after-school activities and summer camps that are communally focused and centered around real world problems have been shown to attract females to STEM and increase their STEM interest, achievement, and persistence (Dasgupta & Stout, 2014). Further, in-school and out-of-school time opportunities that focus on real world application of STEM increase STEM interest (Berk et al., 2014; Young et al., 2017).

Blue STEM Camp, a program created to offer STEM exposure to middle school aged students identified as underrepresented in STEM, conveyed similar findings as the aforementioned programs. For purposes of the study, underrepresentation refers to populations such as "students of color, females, and students from low socioeconomic backgrounds" (Mohr-Schroeder et al., 2014, p. 291). Program researchers reported students who participated in the camp showed increased attitudes, perceptions, and interest in science over the 5-day camp. Campers described "hands-on" experiences as the most useful and fun (Mohr-Schroeder et al., 2014). Similarly, a case study conducted at a charter school in the Southeast United States explored the experiences of students in an after-school program and highlight real world application, as well as communication and collaboration as key to shifting student interest toward STEM fields (Sahin, Ayar & Adiglezal, 2014). The crucial element of camps, clubs, and after-school programs is pre-collegiate STEM exposure.

STEM-related club offerings at typical middle and high schools can include Robotics, Science Olympiad, Science Fair, Rocketry, HOSA, Bio Olympiad, Girls Who Code, and Mathletes. Often these programs include presentations, competitions, afterschool hours, and travel time, as well as a resources, special funding, parental involvement, and willing faculty sponsors (Graham et al., 2013; Portz, 2015; Stanford et al., 2016). STEM-based after-school programs are making a positive impact on students who participate–not only have students reported "[excitement]," but they have also indicated that they have "[begun] to see themselves as potential contributors to the STEM enterprise" (Krishnamurthi, Ballard, & Noam, 2014, p. 2). Participation in high school STEM-based clubs is linked to higher post-secondary matriculation in STEM majors as compared to the national average (Sahin, 2013).

In-School STEM Programs

While not specifically focused on female students, findings from a study on the impact of simulation-based science coursework in a high school setting indicate a positive impact on student retention in STEM (Berk et al., 2014). The program design offered real world application of science within the school day and promoted students' self-efficacy in an educational setting. Alumni from the program reported enthusiasm for STEM careers attributing high levels of interest and confidence in science or healthcare related fields (Berk et al., 2014).

Earlier exposure to meaningful learning opportunities in STEM may increase the persistence of females in STEM programs, so educational institutions should offer them sooner. According to Graham et al. (2013), "most undergraduates are not offered research opportunities until late in college, after the critical period of attrition from STEM," as there is a decided lack of research opportunities at the pre-collegiate level (p. 1455). Olson and Riordan (2012) recommended the implementation of research-based coursework in STEM for all students beginning in undergrad; however, high school students could benefit from this opportunity as well. In this case, "research-based" is intended to indicate time spent in a traditional laboratory setting conducting exploratory STEM research and not seeking literature that supports a strategy for implementation of curriculum. As stated by Dabney et al. (2012), there is a significant correlation between school STEM related activities and STEM career interest in female students.

Other STEM programs offered by traditional high schools include advanced core science courses and applied science courses like healthcare and biotechnology (United States Department of Education, 2014). While these courses are beneficial, they must stick to a strict schedule in order to meet standards, often to the detriment of extended lab time (Traphagen, 2011). Factors such as classroom size, size of classroom population, and availability of resources are often insufficient to support inquiry-based lab investigations. In traditional high school settings often classrooms are too small, class sizes are excessively large and resources are scarce (National Science Teachers Association [NSTA], 2014). The aforementioned variables are often deterrents to opportunities for students to conduct individual or group hands-on research-based STEM activities (NSTA, 2014; Traphagen, 2011).

Characteristics of Effective STEM Programs

While there is a decided gap in the literature regarding factors that specifically influence the persistence of female high school students in STEM, findings from studies conducted across K-26 educational levels identify several key personal factors as indicators of STEM matriculation including attitudes about science. These attitudes include self-perception, self-doubt/self-confidence, stereotyping, and gender bias, which inform program decisions, and contribute to the retention of female students in STEM programs. (AAUW, 2010; AWS, 2016; Correll, 2001, 2004; Kahle et al., 1993; Nosek, Banaji & Greenwald 2002a, 2002b; Esparza, Shumow, & Schmidt, 2014).

A myriad of variables are identified in the literature as contributors to the attitudes females form regarding STEM. Variables that characterize effective STEM programs include; mentoring and female role models (Bottia et al., 2015; Cutright & Evan, 2016), project-based learning (Scutt et al., 2013), individualized education (PCAST, 2012), soft skills acquisition (Darling & Dannels, 2003; Dasgupta & Stout, 2014), and active learning incorporating real world experiences (Capraro et al., 2017; Dasgupta & Stout, 2014; PCAST, 2012).

Science Attitudes

In female students, perceived science ability, self-confidence in task performance, achievement in math and science, and motivation are factors linked to attitudes about science and persistence in STEM (Kahle et al., 1993; Wang, 2013). Moreover, female students underestimate their math and science capability regardless of ability (Nosek, Banaji, & Greenwald, 2002a). Shumow and Schmidt (2013b) explain that if males and females have different attitudes about science, then different factors would motivate them and thus engagement in science would present differently. The current educational system in the United States produces STEM ready males at a disproportionate rate to STEM ready females (Tanenbaum, 2016). If females experience meaningful exposure to STEM programs within the U.S. educational system that ameliorate these attitudes, female matriculation in STEM majors, programs, and careers may increase, reducing the gender gap in STEM. Scientific literacy, teamwork, and communication are key and crucial components to effective STEM programs (Darling & Dannels, 2003; Seat, Parsons & Poppen, 2001). The aforementioned components are especially important for females as attitudes about science do not appear to be linked to what is being taught as much as they are associated with who is doing the teaching and how the educator communicates content (Shumow & Schmidt, 2013a). If females experience meaningful exposure to STEM programs that amend these attitudes, female matriculation in STEM majors, programs, and careers may increase (Shumow & Schmidt, 2013a).

Self-Perception, Self-Confidence, and Self-Doubt

In *Why So Few? Women in Science, Technology, Engineering and Mathematics*, findings suggest that “bias, often unconscious, limits women’s progress in scientific and engineering fields" (AAUW, 2010, p. xvi). There is a systemic problem within public education with regard to female perceptions of ability and the differences in the way males and females view themselves as capable mathematicians and scientists. In agreement with findings from the AAUW (2010), Thomas (2017) reported females indicate a need to achieve at exceptionally high levels to consider themselves successful in STEM courses. Correll (2004) supported the notion that females require higher scores (grades) in order to perceive themselves as skilled in mathematics and scientific processes. Correll's (2004) study is important as it speaks to perceived abilities in math and science rather than actual abilities in math and science.

Sheldrake, Mujaba, and Reiss (2014) explained males tend to over-estimate their performance in mathematics as compared to females, but self-reported beliefs may or may not indicate actual abilities. Correll (2001) explained differences in the self-assessments of males and females regarding perceived English and mathematics abilities may play a role in the career choice process. Data from Correll's (2001) study indicates "higher English grades and test scores actually lead to lower levels of mathematical self-assessment for both males and females," (p. 1716) but the negative effect is stronger for females than males. This finding is consistent with the notion that females avoid advanced STEM courses and math and science related careers because they underestimate their capability even though they have the necessary skills for success (Nosek, Banaji, & Greenwald, 2002b; Phillips, 2017; Reuben, Sapienza, & Zingales, 2014). Nosek, Banaji, and Greenwald (2002a) administered the Gender Science Implicit Association Test (GSIAT) to male and female students in order to measure the association between math and arts between males and females. Results from the GSIAT indicated more than 70% of students associated “male” with science and “female” with arts (Nosek, Banaji & Greenwald, 2002a). Researchers in a follow-up study conducted at Yale University ascertained that males reported more positive self-evaluations of math-science abilities when compared to females (Nosek, Banaji & Greenwald, 2002b).

Anft (2017) explored variables that retain female undergraduates in engineering and computer science. Anft (2017) stated there is no difference in the capabilities of males and females in computer science providing females have access to the same mentoring, collaborative environment, and professional development opportunities as males. An interview with a female undergraduate student double majoring in computer science and robotics at Carnegie Mellon University revealed past gender bias. Even with excellent grades in STEM coursework and a leadership role in the robotics club in high school, the undergrad student reported she stood out because of her gender and had to get used to being the only female in a room (Anft, 2017). The undergraduate student explained “[she] was often talked to differently simply because [she] was female” (Anft, 2017, p. A8).

Thomas (2017), a former Massachusetts Institute of Technology (MIT) female student and current professor of mechanical-engineering, revealed feelings of inadequacy and “terror” at not being good enough. She also reported having no female professors in her STEM coursework during her 4 years at MIT. While there was not a single model for what success in STEM looks like, representation matters and female STEM students need to see female STEM professors (Thomas, 2017). Research findings across multiple studies suggest an increase in female attitudes about science and thus persistence in STEM degree programs and careers when female students have access to other females in

STEM careers (Dasgupta & Stout, 2014; NSB, 2015). Additionally, it is important to support female students in their STEM endeavors by providing access to female professionals with whom they can identify (Bottia et al., 2015). Since female students tend to underestimate their math and science capabilities (Phillips, 2017), it is imperative to dissuade the notion that females have to be “superwoman” to succeed in STEM (Thomas, 2017). If perfection is not attainable, i.e. “superwoman,” females do not feel good enough and attrition rates rise (Thomas, 2017).

Stereotypes and Gender Bias

Research findings provide accumulating evidence of gender bias in STEM fields (Banaji & Greenwald, 2016; Moss-Racusin, Molenda, & Cramer, 2015; Thoman & Sansone, 2016). In a study linking gender differences and performance in math and science, Nosek et al. (2009) hypothesized a two-way relationship may exist between variables where stereotypes linking science with males actually perpetuates gender differences in performance achievement and then the gender differences in performance reinforce the stereotype linking males to science thus creating a negative feedback loop for female students. A lack of diverse representation in STEM degree majors and careers causes “negative stereotypes surrounding gender and race [which] have the capacity to limit expectations and often create self-fulfilling prophecies” (Bhatt, Blakley, Mohanty, & Payne, 2015, p.3) regarding STEM attitudes and abilities. Since there is a disconnect in reported abilities and actual abilities in math and science by female students (Nosek, Banaji, & Greenwald, 2002a), effective pre-collegiate STEM programs must address gender issues in STEM by offering adequate female representation, as gender bias produces gender gaps in STEM degree programs and careers (Moss-Racusin, Sanzari, Caluori, & Rabasco, 2018).

The Trends in International Mathematics and Science Study (TIMSS) is a comparative study focusing on student achievement in math and science across time and space (NCES, 2015). The TIMSS is sponsored by the Evaluation of Educational Achievement and managed by NCES under the supervision of the U.S. Department of Education. Data have been collected every 4 years since its inception in 1995 and over 60 countries participate in the assessment delivered to students in grades 4 and 8. A synthesis of results from TIMSS data by AAUW (2010) indicated that in countries where males identify males with science, females are less likely to achieve on par with their male peers in science creating a gender gap in STEM degree programs and careers. Study findings are reinforced by data collected by the AAUW (2010) indicating the gender gap is greater in achievement in both math and science for eighth grade middle school students if stereotypical ideals about gender roles exist. Implications of the research gathered on gender bias by the AAUW (2010) suggested:

> Implicit biases against women in science may prevent girls and women from pursuing science from the beginning, play a role in evaluation of girls' and women's coursework in STEM subjects, influencing parents' decisions to encourage or discourage their daughters from pursuing science and engineering careers, and influence employer's hiring decisions and evaluations of female employees. (p. 78)

According to the Association for Women in Science (AWS, 2016), human beings subconsciously harbor bias that reflect the culture in which they were raised. If a culture of males equal science and females equal arts persists, it makes sense that female students would start to believe that females do not equal science. Banaji, a social psychologist at Harvard, is most well-known for work with implicit bias and gender. In a statement made to the AAUW (2010) regarding gender bias in STEM for the data synthesis work on *Why So Few? Women in Science, Technology, Engineering and Mathematic*, Banaji stated:

> The degree to which the idea that girls aren't good at science is in the air we breathe, the more likely it is to show up in patterns of attitudes, beliefs and performance. If you look around you and only a fraction of those doing science come from group A, what are members of group A and B to think? It doesn't take too many neurons to figure out that perhaps group A isn't so good at science. (p. 78)

Recent study findings by the AAUW (2016) further substantiate the need to address gender bias and stereotypes in pre-collegiate STEM programs by offering "regardless of our consciously held values, implicit biases can creep into our thinking and decision making" (p. 2) therefore it is imperative that those who implement STEM programs be cognizant of these underlying bias and offer opportunities to remediate female attitudes towards STEM abilities by providing access to strong female role models (AWS, 2016).

Role Models and Mentoring

National Girls Collaborative Project (NGCP, 2016) calls for organizations like Million Women Mentors, Ace Mentor Program, Collaborative for Gender Equality, and other like programs to unite and get involved in leading young females towards greater interest and thus achievement in STEM degree programs and careers. Funded by the National Science Foundation, NGCP supports 31 collaborative programs focused on serving females who are most underrepresented in STEM by expanding professional learning and making research-based resources, such as curriculum material and instructional software, available to educators of female-serving STEM programs in the United States. With the major goal of bringing together females committed to encouraging young females to pursue STEM, NGCP focuses on the role mentors play in encouraging the next generation of female scientists (2016). There is a recognized need for more approachable female role models; females need to have access to other females in STEM who see their work as enjoyable and relevant (Dasgupta & Stout, 2014; NGCP, 2016; NRC, 2011; NSB, 2015). Programs like FabFem intend to broaden participation of females in the STEM pipeline by connecting female youth with appropriate mentors because these mentor relationships are so instrumental in retention and advancement of females in STEM based careers (FabFem, 2015). Chesler and Chesler (2002) call for improved mentoring as a strategy for increasing presence, retention, and advancement of females in STEM. In an innovative program funded by the NSF, senior students mentored freshmen for course credit; each time they met for their class, STEM skills and topics were discussed, and data showed both the senior and freshmen students believed this mentor/mentee relationship was beneficial to their education (Cutright & Evans, 2016).

The results of a study conducted with students who spent their secondary years in North Carolina public schools and went on to attend public universities in North Carolina revealed there is a relationship between female math and science teachers and the participation of students in STEM (Bottia et al., 2015). They suggested that the number of female math and science teachers at a school does not have an impact on male students; it has a "powerful effect" on female students and their probability of declaring a STEM major and matriculating in a STEM degree program. The correlation was highest amongst female mathematics students. As stated by Maltese and Tai (2011), students make choices about whether to pursue a collegiate STEM degree in high school indicating a need for more female STEM teachers. The National Center for Educational Statistics (2015) indicated that while the majority of public school educators are female, the number of female mathematics and science instructors is disproportionate to the overall number of teachers in a large percentage of schools. The lower number of female math and science teachers relative to male math and science teachers perpetuates the pervasive gender stereotypes about math and science as masculine domains (Bottia et al., 2015). Female math and science secondary educators may help female high school students identify themselves as scientists (Stearns et al., 2016; Stout, Dasgupta, Hunsinger, & McManus, 2011). Study findings substantiate the notion that there is a link between inspiration and STEM persistence in females (Dasgupta & Stout, 2014; Stearns et al., 2016; Stout et al., 2011).

Project-Based Work, Individualized Education, and Choice Behaviors

U.S. educational systems are concerned with figuring out how to revamp STEM education to teach skills, application, and attitudes as well as recall and understanding (Markham, 2018). Scutt, Gilmartin, Sheppard, and Brunhaver (2013) described a need to promote student ownership of project-based work by introducing choice as a STEM teaching strategy. Project-based work in science is described as activities which emphasize core practices such as conducting investigations (Chen, 2014). Project-based learning is offered as a way to promote student-centered classrooms which focus on individualized education and choice in learning (Scutt et al., 2013). Problem-based STEM programs where an "errors are fine" philosophy is employed may have a positive impact on student achievement in science (Markham, 2018). Students involved in a project-based physical science class performed 8% better on an end-of-unit learning assessment over students in a physical science class which did not employ the student-centered, project-based work model (Chen, 2014). When students are offered opportunities to engage in project-based learning which promote individualized education and choice behaviors, student ownership of learning is positively impacted which may be able to narrow gender gaps in STEM achievement (Chen, 2014).

Student ownership is positively impacted by choice in assignments or ability to select topics of interest to further explore and thus increasing student interest (Scutt et al., 2013). Researchers in a synthesis study analyzed discipline-based educational practices (DBER) in STEM detailing the difficulties students encounter in highly specialized content areas, such as math and science courses, where instructional practices do not match the needs of the learners (NRC, 2012). Study findings indicated effective instructional practice takes into account the needs of the student in terms of individualized support and comprehension. Consequently, if students are going to be appropriately challenged in STEM, educators need to offer programs that promote authentic science experiences in a supportive setting.

The President's Council of Advisors on Science and Technology (2012) considered the work of DBER and recommended an overhaul of STEM education to include the replacement of traditional lab-based coursework with discovery-based courses that promote student choice and individualized learning scenarios. Traditional lab-based courses offer students the opportunity to follow directions instead of problem solving and are passive, product oriented experiences instead of active, process oriented experiences (Sibler, 2018). Traditional lab-based coursework may not offer enough opportunities for critical-thinking, creativity, and analytical evaluation (Gallant, 2010; PCAST, 2012. Holistic experiences that mirror the scientific process are more likely to increase ownership and thus persistence of females in STEM degree programs (Graham et al., 2013; PCAST, 2012).

Soft Skills Integration

Success in STEM is more than just exposure to challenging coursework. Life sciences, physical sciences, and engineering degree programs and careers involve intense collaboration within teams (Dasgupta & Stout, 2014) as well as a focus on communication and leadership (Darling & Dannels, 2003; Seat, Parsons, & Poppen, 2001). An emphasis on oral communication and active learning experiences within curricula is shown to improve success in high school STEM courses and later in selecting STEM careers (Capraro et al., 2017; PCAST, 2012). Active learning experiences in science are described as experiences which help students understand science through inquiry, gathering and analyzing data, and applying scientific knowledge. When active learning experiences are combined with opportunities for teamwork and collaboration, student interest in STEM coursework may increase.

Soft skills include team work, clear writing, strong oral communication, collaboration, critical thinking, problem-solving abilities, and creativity and are cited as necessary and essential to any STEM setting (Hemesath, 2016; Long III & Jordan, 2016; Olson & Loucks-Horsley, 2000). Communication for the purpose of "[using] scientific and technological information correctly" has been incorporated into the Georgia Standards of Excellence which were approved in 2016 and rolled out to school systems in 2017 (Georgia Department of Education [GaDOE], 2016, 2017). While scientists are expected to communicate, share, and verify findings as a part of the scientific process, leadership, creativity, teamwork, and collaboration are often underemphasized in traditional lab-based coursework. There has been a call by universities to include more soft skills in hard core science curricula to better prepare students for industry life (Zafft, 2018).

Despite the importance of soft skills in STEM, these skills are often seen as the opposite of math and science (Scutt et al., 2013). Communication skills are often depicted as "exclusive" from math and science thus making it seem like one can only be good at communication or math and science (Correll, 2001). These stereotypes are detrimental to female students in particular who may not feel they can be as successful in STEM if they are successful communicators and collaborators (Scutt et al., 2013). Helping young female students understand that STEM and communication are not mutually exclusive fields should be a top priority in STEM education as soft skills are still needed in the hard sciences (Zafft, 2018). Capraro et al. (2017) argued communication is an important 21st century skill explaining communication is necessary "in order for people to share knowledge, describe things, encourage others, and justify and reason" (p. 29).

Almost two decades ago, Seat, Parsons, and Poppen (2001) stated the stereotypes of scientists, mathematicians and engineers working as solitary individuals is a myth and that 21st century STEM professionals "must be team members who thrive while working with a variety of people having differing social, educational, and technical skills" (p. 8).

Teamwork and collaboration, as well as leadership capabilities and the ability to present, discuss, and communicate findings are all the reality of the 21st century STEM careers (Markham, 2018; Zafft, 2018). Educators must encourage learning that takes into account both STEM and oral/written communication if they want to promote cooperative communication in the classroom. These active classroom settings are seen as particularly attractive to female students (Capraro et al., 2017), so it is incumbent upon STEM educators to offer students opportunities to integrate curriculum with reading, writing, and speaking components.

Active Learning and Real World Application

Historically, lecturing has been the preferred mode of instruction by STEM educators (Gallant, 2010). Active learning is shown to be a key contributor in female persistence in STEM (Graham et al., 2013). Active learning is defined as any activity where students are asked to solve problems, think about applications and apply their own knowledge for purposes of understanding. Active learning is anything that involves students doing and thinking about things as opposed to just watching, listening and taking notes (Bonwell & Eason, 1991; Felder & Brent, 2009).

Freeman et al. (2014) stated active learning increases examination performance and lecturing alone increases failure rates by 55%. While the aforementioned study was conducted at the university level, there is reason to believe educational interventions such as increased active learning activities at the pre-collegiate level would also be impactful. If active learning promotes increased performance over lecture alone, it stands to reason that programs that promote active learning could make a significant impact on the STEM pipeline leak, especially considering that active learning has been shown to have disproportionately large benefits for female STEM students in male-dominated areas (Lorenzo, Crouch & Mazur, 2006).

STEM professionals are rapidly becoming the most marketable individuals in the professional world (AAUW, 2018). Despite the demand for STEM professionals, female students walk away from the STEM educational pathway at a disproportionate rate to their male peers (AAUW, 2018). Many female students begin to feel undecided about STEM fields by middle and high school, and by the end of high school fewer female students than male students report an intention to major in collegiate STEM degree programs (AAUW, 2018; Maltese & Tai, 2011). Research findings suggest STEM programs, which offer opportunities for additional exposure to STEM, and incorporate hands-on, active learning experiences positively impact student learning (Scutt et al., 2013). Additionally, active learning incorporating chances to apply scientific knowledge to real world scenarios are linked to increased interest in STEM coursework (Capraro et al., 2017; Dasgupta & Stout, 2014; PCAST, 2012). Finally, when STEM programs take into account gender bias, stereotyping, and science attitudes, and offer female role models and mentors, female student interest in STEM increases (AWS, 2016; Moss-Racusin, Molenda, & Cramer, 2015; Robnett, 2016). Consequently, STEM programs which consider the aforementioned variables may have a positive influence on female matriculation into collegiate STEM degree programs and into STEM careers, thus reducing the gender gap in STEM fields.

Theoretical Framework

The theoretical framework underlying this study combines aspects of Social Cognitive Theory (SCT) and Social Cognitive Career Theory (SCCT) in order to understand the unique needs of female students in terms of STEM interest, collegiate retention, and career choices. SCT holds that people learn from one another and an individual's knowledge acquisition is directly related to observing, imitating, and modeling (Bandura, 1986). SCCT posits that environmental, personal, and behavioral variables intertwine to determine choice behavior such as career choice (Lent, Brown, & Hackett, 1994). SCT and SCCT are used in this study to understand how learning occurs and the impact of environmental, personal, and behavioral variables on female students' interest in STEM and choice to matriculate into collegiate STEM degree programs. SCCT provides a platform to explore the interrelatedness of variables, which informs how academic and career interests are formed and how choices regarding matriculation into STEM degree programs occur. A myriad of variables is proposed to influence personal choice such as interests, abilities, values, experiences, and engagement (Betz & Hackett, 2006). Under SCCT, variables are categorized within environmental factors, personal factors, and behavioral factors (see Figure 2). SCCT suggests these factors intertwine when people make choices about academic choice behaviors and career goals (Lent, Brown, & Hackett, 1994).

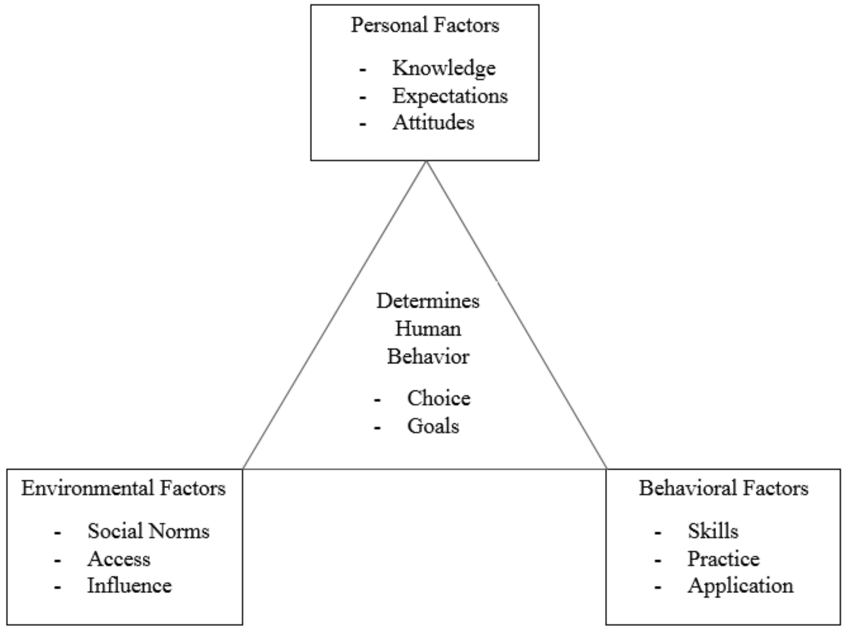

Figure 2. Personal, environmental, and behavioral factors affecting human behavior, choices, and goals as described by Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994).

Social Cognitive Career Theory derives its beginnings from Bandura's (1986) Social Cognitive Theory (SCT). Social Cognitive Theory identifies personal factors, behavior and environmental influences as attributes of human disposition introducing self-efficacy as a key construct of SCT (Bandura, 1986). Here, self-efficacy refers to one's belief in one's own ability to succeed at specific tasks and is influenced by personal performance accomplishments, social persuasion, and vicarious experiences (Bandura, 1986). Bandura (1977) previously identified several factors as simultaneous and interactive contributors to self-efficacy (p. 195):

1. Performance accomplishment including participant modeling, performance desensitization, performance exposure, and self-instructed performance.
2. Vicarious experience via live modeling and symbolic modeling.

3. Verbal persuasion including suggesting, exhortation, self-instruction, and interpretive treatment.
4. Emotional arousal via attribution, relaxation, and biofeedback.

Bandura (1989) suggested that what we do and who we spend time with greatly impacts self-efficacy in his model of reciprocal determinism suggesting a need to further explore the relationship between self-efficacy and career choice in females.

Hackett and Betz (1981) first suggested a model of SCCT exploring the connection between self-efficacy and career choice and underrepresentation of females in male dominated fields. Lent, Brown, and Hackett (1994) introduced a model of a threefold building block system consisting of self-efficacy beliefs, outcome expectations, and goals to explain how these factors can be linked to career choice (see Figure 3). Sources of self-efficacy include personal performance, vicarious experience, social persuasion, and psychological and emotional states, while outcome expectations are identified as outcomes or consequences of performing behaviors and goals are the intention to engage in certain activities (Lent et al., 1994). SCCT ascertains that career interest is regulated by self-efficacy and expectations of an outcome; people will persist in areas where they feel personal connections, competency, and positive outcomes (Lent et al., 1994). Self-efficacy has been identified as an important factor in the career choice of females (Zeldin & Pajares, 2000). In a study conducted by Betz and Hackett (2006) examining the relationship between self-efficacy and attitudes towards mathematics and mathematics-related majors, findings indicated that self-efficacy was a significant predictor of STEM career choice in females.

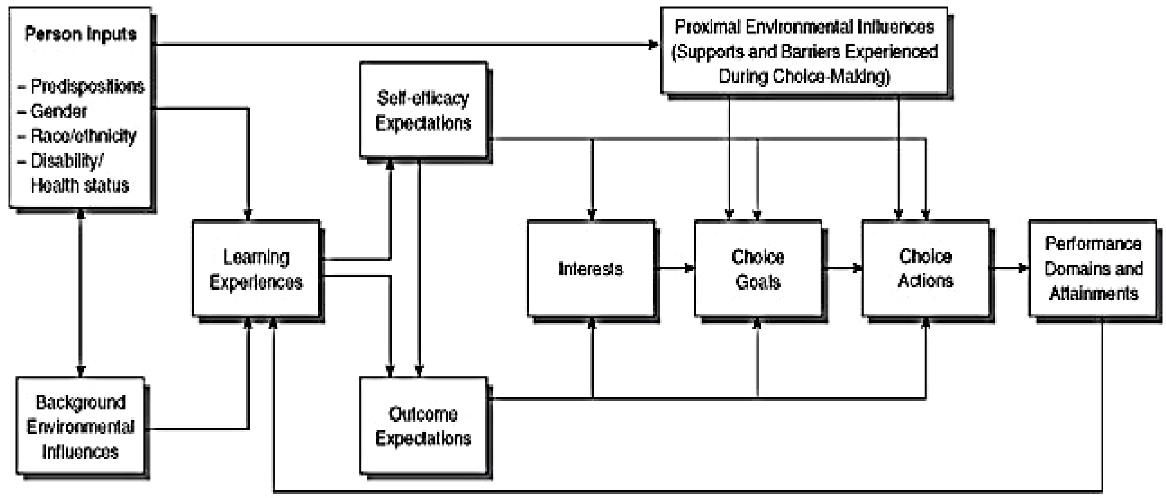

Figure 3. Factors influencing how students' learning experiences affect career-related interests and choice (Lent, Brown, & Hackett, 1994, 2000).

The goal of SCCT is to highlight areas that may influence career selection. Social Cognitive Career Theory provides a framework for understanding females' career choice. Environmental factors such as exposure, experiences, and access and personal variables such as knowledge, expectations, and attitudes as well as behavioral factors such as opportunities for practice and application are all identified as impactful components of behavior and career choice (Lent et al., 2000).

SCCT considers the interaction of environmental, personal, and behavioral variables on individual choice behaviors and career choices. Pre-collegiate STEM exposure in high school can provide supportive learning environments affording students, females in particular, access to STEM degree programs and STEM careers. Participation in pre-collegiate STEM programs can offer opportunities for female students to be influenced by not only curricula but by social interactions from peers and instructors to pursue STEM degree programs in college and STEM careers. Moreover, social norms can be modeled so that personal factors such as positive attitudes towards science can be nurtured. Lastly, behavioral factors can be sustained when students apply learned skills in STEM activities.

Self-efficacy is supported by STEM exposure or environmental factors, as it provides female students with chances to apply scientific knowledge in new ways. The application of knowledge leads to personal accomplishments or successes with STEM related tasks, thus positively increasing emotional states. Additionally, self-efficacy is attained through mastery experiences, which are achieved by extended and repetitive exposure to STEM. Mastery experiences are linked to increased feelings of efficacy. Lastly, participation in pre-collegiate STEM programs offer opportunities for vicarious experiences, or observing others with whom female students can identify such as female role models. When environmental, personal, and behavioral variables linked to increased interest in STEM are considered in pre-collegiate STEM programs, female interest in collegiate STEM degree programs and STEM careers may be positively impacted.

Chapter III

METHODOLOGY

"The development of lifelong learners is an oft-touted, rarely achieved goal of almost every educational enterprise" (Koschmann, Myers, Feltovich, & Barrows, 1993, p. 232).

Statement of Purpose

The purpose of this study was to explore the lived experience of female students who participated in the Student Lab Assistant Research Program (LAB) to better understand the impact of this pre-collegiate STEM opportunity on female students' interests and beliefs about STEM. While the LAB included both male and female students, in this study the experiences of female students were examined. As part of the LAB, these female students provide a unique opportunity to explore the perceptions and thoughts of high school students necessary for an evaluation of a student lab assistant research program. To better understand the complexities and needs of this group of female students, the LAB may be studied to help identify best practices influencing the meaning of these female students' experiences and illuminate best practices influencing female matriculation in STEM degree programs and STEM careers. Thus, policies that encourage female growth in collegiate STEM degree programs and careers can be supported. Study findings may be useful to stakeholders charged with promoting STEM education to female students and improving the diversity of the STEM workforce (SCHELP, 2015; White House, 2015).

In this chapter, I describe the selection of the research design for this study, along with a rationale for the design and its alignment with my research questions. My role as the researcher is discussed including any potential bias I may hold in regards to this study. Methodology is described in detail followed by site and participant selection, data collection procedures, and the data analysis plan. Finally, issues of credibility including trustworthiness, limitations, and delimitations are detailed along with protection of human rights.

Research Design and Rationale

In this study, the lived experiences of female high school students who serve as lab assistants were explored. According to Yin (2003), ". . . a research design is *a logical plan for getting from here to there*, where *here* may be defined as the initial set of questions to be answered, and *there* is some set of conclusions (answers) about these questions" (p. 26). Because there are many factors that contribute to understanding the impact of a lab assistant program on the participants, a qualitative study is appropriate as it allowed for a complex grasp of experiences that are difficult to measure quantitatively (Creswell, 2013) and cannot be determined by statistical procedures (Strauss & Corbin, 1990).

The goals of this study were met using qualitative methodology, which is appropriate because of the nature of the research questions. The research questions necessitate the exploration of individual experiences and call for descriptions of meaning thorough participant reconstruction. This methodology allowed me to "forge a common understanding" (Creswell, 2003, p.62) of female participants' experiences and extrapolate findings so the implementation of a similar program elsewhere could facilitate similar lived experiences. The objective of having these research questions is two-fold: to explore the lived experience of female lab assistants and to showcase the LAB, a pre-collegiate STEM opportunity that can support and develop positive behaviors in females toward STEM, as a means of getting more female students interested in STEM careers.

According to Merriam (2009), “Qualitative researchers are interested in understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences” (p. 5). Within the realm of qualitative research, there are a variety of potential research designs including narrative, grounded theory, case study, ethnography, and phenomenology (Creswell, 2009). Phenomenological research is a strategy to describe the meaning of the experiences lived by several individuals and to understand the core of their experiences (Creswell, 2009; Hatch, 2002; Lester, 1999; Polkingham, 1989) in an effort to identify patterns and relationships of meaning (Moustakas, 1994). Moustakas (1994), explained that data and evidence from phenomenological studies are derived from first-person reports of lived experiences. Creswell (2009) recommended using the phenomenological methodology when the purpose of the study is to describe the shared meaning of several individuals and their lived experience or phenomenon. Lester (1999) noted that this methodology is best when concerned with the study of experiences from the perspective of the research participants.

Polkingham (1989) shared that “the phenomenological map [refocuses] inquiry, concentrating not on descriptions of world objects but on descriptors of experience” (p. 41) and the aim of the phenomenological research approach is to provide an accurate and clear description of a particular aspect of the human experience (Polkingham, 1989).

Using phenomenological inquiry, I gathered data via one-on-one interviews that gave the participants their own voice, describing the phenomenon of participation in the LAB program. I used the data to ascertain information about the impact of participation in the LAB program on beliefs about and interest in STEM.

A social constructivist lens was used in order to understand the role of the LAB in the lives of female students who recently graduated from high school (Creswell, 2009). This lens is appropriate as it allows for a reliance on the accounts of the participants. The meaning of these females' experiences "are not simply imprinted on individuals but are formed through interaction with others and through historical and cultural norms that operate in individuals' lives" (Creswell, 2013). According to Creswell (2009), "Social constructivists hold assumptions that individuals seek understanding of the world in which they live and work [and] the goal of the research is to rely as much as possible on the participants' views of the situation being studied" (p. 8). Social constructivist ideals are consistent with the goals of phenomenological studies (Mertens, 2009; Moustakas, 1994).

Research Questions

The purpose of these research questions was to create a platform to explore the lived experiences of female high school students who participated in the LAB and determine what program improvements they might suggest to increase female matriculation in collegiate STEM degree programs. These data can be used to fuel future research about student lab assistant research programs.

The research questions that guide this study are:

1. What are the perceptions of female lab aides about the impact of participating in LAB on their beliefs and interests in STEM?
2. What do female lab aides perceive as LAB elements most beneficial to their beliefs and interests in STEM? What elements are the least helpful?

   2A. What do female lab aides suggest to improve the LAB and, perhaps, to increase the number of female students interested in collegiate STEM majors?

Role of Researcher

Characteristics of qualitative research allow researchers to "lessen distance between himself or herself and that being researched" (Creswell, 2007, p. 17). Usually data collection takes the form of individual or focus group meetings, conducting interviews, and taking field notes (Moustakas, 1994). Sometimes researchers must review journals, survey responses, transcriptions, or stories in order to understand the meaning of an experience (Creswell, 2007). In any case, it is necessary that qualitative researchers take careful precautions to free themselves of suppositions (Husserl, 1983). Because of the close working relationship with participants, the researcher must adhere to strict ethical guidelines. Researchers serve as active participants or co-researchers who are charged with retelling the stories of the participants from their point of view without drawing any conclusions of their own (Moustakas, 1994). It is necessary that the researcher adhere to the concept of "epoché" within the study by leaving bias behind and focusing only on what the participants describe as their own personal experiences (Creswell, 2007; Moustakas, 1994).

Moustakas (1994) explained in order to achieve epoché or bracketing, one needs to set aside "predilections, prejudices, predispositions and allowing things, events, and people to enter anew into consciousness, and to look and see them again, as if for the first time" (p. 85). If epoché is to be achieved, the researcher must take "no position whatsoever" and take into account "only what enters freshly into consciousness, only what appears as appearance, has any validity at all in contacting truth and reality" (Moustakas, 1994, p. 87). The researcher must bracket all personal experiences in order to obtain a fresh, new perspective not tainted by personal experiences and history (Creswell, 2007), but instead has "been cleared of ordinary thought and present before us as phenomenon to be gazed upon, the be known naively and freshly through purified consciousness" (Moustakas, 1994, p. 85).

In order to achieve epoché or bracketing, during each participant interview I listened intently and made notes while following the interview protocols described by Seidman (2006) It was necessary for me to use my professional judgement during interview questioning in order to maintain the focus of each interview without imposing personal attitudes or adding information from personal experiences to the content or meaning of participant responses (See Appendix A). According to Seidman (2006), it is the job of the researcher to find a balance between providing enough openness for participants to share their experiences while still maintaining the integrity of the three-interview series. Marshall and Rossman (1999) noted researchers who fail to observe epoché or effectively bracket run the risk of biasing the study with personal interest.

During participant interviews, I refrained from personal comments that would influence responses concerning participation in STEM or the LAB. Every attempt was made to engage in epoché to assist in creating an atmosphere and develop a rapport that was appropriate for conducting interviews in accordance with Moustakas (1994). I eliminated personal bias due to familiarity with the LAB and the study participants and focused only on what the participants described as their personal experience. Due to a strong interest in the phenomenon being studied, I paid careful attention to bracket experiences and personal bias. In doing so, I obtained a fresh, new perspective of the LAB.

Careful attention was paid to establish a feeling of trust between myself and the participants (Quinney, Dwyer & Chapman, 2016). Lester (1999) explained that when a participant has a strong personal stake in the subject matter, it is imperative that the researcher builds rapport and practices empathy in order to gain more depth of information from the research participants. Quinney, Dywer, and Chapman (2016) explain that “pre-existing relationships can lessen the time taken to build rapport and enable the interview to move quickly toward a shared dialogue of experiences” (p.3). Easily established rapport was achieved by my many years of experience with STEM, the LAB, and secondary schools. Additionally, as the LAB coordinator I established familiar relationships with the participants during their experience in the LAB and this positive rapport was helpful during the interview process. According to Seidman (2006), the duration of the interviews and the spacing of contact between interviewer and interviewee “[affected] the development of the relationship between participants and the interviewers positively” (p. 21). The number and length of each interview was outlined in Seidman’s (2006) protocol as appropriate for these interviews. The interview period allows for enough time for participants to fully develop responses while feeling like their participation in the study is legitimate and that their experiences are valuable. The spacing between interviews allowed participants time for reflection. As suggested by Moustakas (1994), I bracketed all personal experiences related to the LAB and, as the interviewer, became the research instrument. This allowed me to use what was seen and heard to make meaning of the phenomenon while seeking to learn about the lived experiences of female students who participated in the LAB (Moustakas, 1994).

Methodology

The experiences of female participants were collected and audio-recorded following Seidman's (2006) three-interview series to uncover the nature of each participant's experiences with the LAB. Participants were asked to describe their experiences with the LAB and then discuss their suggestions for the future of the program by participating in three 90-minute interviews. Seidman (2006) explained that an hour is an anticipated standard unit of time and may lead to distraction in participants, while two hours is too long for participants. Creswell (1998) suggested that lengthy interviews with no more than ten people are characteristic of phenomenological studies. It was necessary to share the interview length with participants so they could budget their time accordingly. According to Seidman (2006), "rather than seeming too long, it's long enough to make [the participants] feel they are being taken seriously" (p. 20). Additionally, Seidman (2006) suggested a minimum of three days between interviews as it allowed the participants to reflect on the interview but not so much time has passed so as to lose the connection between interviews.

Seidman (2006) described a three-interview series in order to thoroughly "[explore] complex issues in the subject area by examining the concrete experience of people in that area and the meaning their experience has for them" (p. 16). Seidman's (2006, pp. 16-19) model for the three-interview series includes:

Interview one: Focused life history.

Interview two: The details of the experience.

Interview three: Reflection on the meaning.

In accordance with Seidman's protocol, each participant was asked to begin the first interview by reflecting on her earliest experiences with STEM and provide a focused life history. In doing so, participants established the context of their life history and focused on the "how" instead of the "why" in terms of involvement in the LAB (Seidman, 2006). During the second interview, participants were asked to "concentrate on the concrete details of the participants' present lived experience" (Seidman, 2006, p. 18) in the LAB in an effort to reconstruct the lived experience of female lab assistants. Reconstruction of lived experiences was achieved by asking participants to share stories and anecdotes as a way of eliciting details. Interview three consisted of asking the participants to reflect on the meaning of the LAB in their lives. Seidman explained that "making sense or making meaning requires that the participants look at how the factors in their lives interacted to bring them to their present situation" and noted "the third interview can be productive only if the foundation for it has been established in the first two" (Seidman, 2006, pp. 18-19). In essence, the third interview allowed participants to draw from interviews one and two and make the meaning of the LAB experience in the participants' lives the central focus of attention.

Site and Participant Selection

I purposefully chose the criterion for selecting a research site based on my interest in the impact of a student lab assistant research program on female students' interests and beliefs about STEM. The criterion used for selecting the research site included choosing a high school where a student lab assistant research program had been implemented.

I investigated the phenomenon through exploring the lived experiences of the female students as they related to my research questions. I purposefully chose a sample size based on specific criterion, feasibility of the project, and to seek saturation of ideas. Strauss and Corbin (1998) described saturation as the point in research where "no new or relevant data seem to emerge regarding a category, and the category is well developed in terms of its properties and dimensions, and the relationships among categories are well established and validated" (p. 212). Seidman (2006) quantified saturation of data as the point where the investigator is no longer discovering anything original from the sample.

When conducting a phenomenological study, there is a narrow range of sampling strategies available because all participants must have experience of the phenomenon (Creswell & Poth, 2017). Consistent with qualitative methodology and phenomenological studies, purposeful sampling was utilized (Creswell & Poth, 2017). Creswell (1998) identified this type of sampling as criterion sampling and stated it "works well when all individuals studied represent people who have experienced the phenomenon" (p. 118). When this strategy is utilized, the researcher can be assured that all participants meet the criterion for the study (Creswell, 1998) and can actively participate as a co-researcher in the investigation because of their shared lived experiences (Moustakas, 1994). As the

LAB program is unique, purposeful sampling was the only way to ensure that all participants had experience with the phenomenon in question.

Several criteria were employed to determine if students qualified to be selected as potential participants for the research. I only included participants who, (a) had completed two or more consecutive semesters in a LAB program, (b) were female, (c) were 18 years of age or older, (d) had recently graduated from high school, (e) were enrolled in a college or university during fall of 2017, and (f) had reported an intention to major in a collegiate STEM degree program. By stipulating that female students had at least two semesters of experience with LAB, I was better able to gather the data necessary to evaluate the impact of the LAB program on female students' beliefs about and interests in STEM. By purposefully choosing students who have recently graduated from high school, the LAB experience was fresh in their minds.

Females who reported having parents involved in STEM career fields were excluded from the study. Subscribing to Rozek, Hyde, Svoboda, Hulleman, and Harackiewicz's (2015) assertion that students with parents who are involved in STEM tend to express a greater interest in STEM, removing students with STEM involved parents reduced participants who may already have formed interest in and beliefs about STEM outside of involvement in the LAB.

Patton (2002) explained sample size is dependent upon what the researcher wants to know and what can be accomplished with available time and resources. Researchers in qualitative methodology seek understandings from sample sizes as small as one participant up to everyone involved in a phenomenon (McNabb, 2002). Creswell (1998) recommended that a phenomenological study involve "long interviews with up to 10 people" (p. 65), while Boyd (2001) suggested research saturation generally occurs with two to 10 research participants. My research sample consisted of five participants. Since I employed a face to face interview design with multiple contacts per participant, this sampling plan allowed for 15 points of contact increasing the chance that the sample's representation of the phenomenon is adequate.

I planned to start with a sample of 5 participants, but I was prepared to broaden the sample up to 10 people if it was needed to further clarify emerging data to a point of saturation (Corbin & Strauss, 1998). The transcripts from fifteen 90-minute interviews across five participants allowed for data saturation.

The actual participants were deliberately invited to participate as they possessed the specific information needed for this study (Maxwell, 2005, 2013). More participants expressed interest in the study than were needed for the study. After eliminating participants who did not meet the specific criteria of the study, the remaining female students were assigned a number and the numbers were used to randomly select five participants.

Each potential participant was contacted via email and asked to review the recruitment flyer and complete a qualifying questionnaire to verify they met the guidelines stipulated by the study. See Appendix B for the recruitment flyer. See Appendix C for the qualifying questionnaire. See Appendix D for a copy of the email. Each potential participant who agreed to consider participation in the study, had an opportunity to meet face-to-face or phone conference with me in order to learn about the study and its purpose. At the initial meetings, the university-approved research consent document was shared and reviewed verbally. A copy of the research consent document can be found in Appendix E. Prior to the implementation of any part of the study, approval was sought from the university's IRB.

Past experiences with STEM coursework and programs in public schools and 12 years of teaching experience in science and science methodology has heightened my investment toward students who are interested in STEM. Corbin and Strauss (2008), suggested a researcher acknowledge their invested interest because "the primary purpose of qualitative research is discovery, not hypothesis testing … not trying to control variables, but to discover them" (pp. 317-318). To some degree, I knew all of the participants in the study. Although researcher bias can never be entirely eliminated from a study, phenomenology calls for the bracketing or setting aside of the researcher's beliefs and personal experiences in order to focus only upon the life experience of the participants (Moustakas, 1994). The "entire research process [should be] rooted solely on the topic and question" (Moustakas, 1994, p. 97).

Background of Student Lab Assistant Research Program (LAB)

Overview

The LAB provides additional science experience to high school students seeking an enriching science education outside what is traditionally offered by public high schools. Traditional science course work often includes set, prescribed curriculum that must be directly followed and lacks the innovation needed to reach a diverse group of learners (Taylor, 2015). The LAB program allows for differentiation and individualized learning opportunities applicable to real world settings, which is shown to increase persistence in STEM degree programs (Kennedy & Odell, 2014; Taylor, 2015). Students need opportunities to explore STEM in ways that integrate science content and methodology in order to initiate legitimate interest (Kennedy & Odell, 2014). Through the LAB program, students have an opportunity to work one-on-one or in small groups with like-minded science department faculty. These partnerships foster the formation of learning communities helping the LAB participants make personal and social connections to their work.

The LAB program offers hands-on experiences that strengthen academic content but also allow students to gain other skills such as collaboration, problem solving, and teamwork. Through focus on innovation, invention, and problem-based learning, students increase their exposure to STEM content. Early exposure to pre-collegiate STEM programs that offer a viable supplement to traditional science curriculum are necessary to increase female matriculation into collegiate STEM degree programs (Cano, Koppel, Gibbons, & Kimmel, 2004; Edzie, Alahmad, & Alahmad, 2015).

Application to the LAB

Students are carefully chosen through an application process which includes a transcript detailing past and current STEM coursework and an essay explaining what they hope to gain from the program and what he or she will uniquely contribute to the program. The LAB applicants are asked to request specific content placement based on area(s) of interest. Content placement requests include a list of content areas where applicants would like extended opportunities to learn, area(s) he or she would like to gain experience, and where he or she feel their skills would be most useful. Prior to the application process, the LAB coordinator surveys STEM teacher mentors to ascertain which faculty members would be willing to take on lab assistants and to determine the number of LAB placements available for the following year.

Selection

Lab assistant selection takes place during March of the spring semester. At this time, a panel of science department members blindly evaluate each application and place those applicants most qualified into LAB positions until all available positions are full. Blind evaluation is achieved by giving LAB applications to uninvolved school personnel and having all personal identifiers blackened out using a permanent marker. A numeric code is created linking a student name with an application number. Only the uninvolved school personnel have information regarding name and number linkage. Once the panel has made their decisions regarding LAB placement, school personnel are asked to supply the names of the students that will be placed the following school year. Qualification is based on past and current coursework, as well as interest and potential for gain, and availability of requested content area.

Placement

Program positions require different skills based on science discipline (e.g. Biology, Chemistry, or Physics) and the lab coordinator matches participants' current skill set and interests to a mentor who can facilitate unique learning opportunities for the lab assistant. For example, a student who expresses an interest in working in a chemistry lab might be offered opportunities to make dilutions or learn how a chemical supply closet is organized and inventoried. During placement, lab assistants learn to set up and break down labs, as well as conduct literature reviews about lab topics. Under supervision, lab assistants test and run new labs to gather diagnostic data as well as aid students and teachers during lab exercises. It is common to see lab assistants helping struggling students. Lab assistants are enrolled in Scientific Research I, II, III, or IV courses based on the number of semesters they have been involved in the LAB. Required coursework includes safety modules and submission of a monthly log detailing what each student accomplished daily in his or her placement. Scientific article reviews and scientific article critiques of primary scientific literature are due quarterly. The aforementioned tasks require students to select appropriate scholarly articles based on his or her own personal interest, think critically about methods, data, and reliability of conclusions, and evaluate primary literature using technical writing. Mentor teachers also complete weekly evaluations of student performance in order to help lab assistants assess their current personal strengths and weaknesses.

Research Site and LAB Program History

Franklin High School (FHS) was chosen as the research site for this study because it had a student lab assistant research program. FHS is a suburban four-year public high school north of Atlanta, GA. The school was ranked 18th in the state with a graduation rate of 98.7% in 2017. The student body makeup was 52% male and 48% female with a student body population of 2741 during the 2017 academic school year. The total minority enrollment is 27% and economically disadvantaged students make up 5% of the student body population. There is a 19:1 student-teacher ratio.

FHS first opened in 2009, with approximately 1400 students in grades 9-11 and currently has an enrollment of just under 3000 students. Members of the inaugural staff of FHS were charged with the task of building a world class science department. In 2009, FHS offered Biology, Honors Biology, Advanced Placement (AP) Biology, Physical Science, Environmental Science, AP Environmental Science, Chemistry, Honors Chemistry, AP Chemistry and Human Anatomy and Physiology. The student schedule at the time allowed for a seven-course load on a hybrid schedule. All classes met every Monday, Tuesday and Friday. Even periods met on Wednesday and odd periods met on Thursday, with an additional period on Wednesdays for advisement and instructional focus. During the 2010-11 school year, FHS added a senior class and the science department added courses in Physics and AP Physics. Each year FHS has continued to add STEM courses as demand and population grew. FHS now offer courses in AP Physics C (both Mechanics and Electricity & Magnetism), AP Physics 1 and 2, Earth Systems, Forensic Science, Essentials of Biotechnology, and Applications of Biotechnology.

In 2008, the Georgia state legislature passed House Bill 1209 which provided for increased flexibility for local school systems to increase student achievement. Due to the flexible seat time afforded to some school systems by Strategic Waivers School System [SWSS], high schools are able to adjust seat time and thus the number of courses taken during a traditional academic day. This flexibility in scheduling afforded students' other growth opportunities outside the traditional high school curriculum. These opportunities include leaving school early for work-based learning, internship opportunities, independent study, and time to take additional core courses outside those necessary for graduation. The goal of SWSS is to use flexibility to improve student achievement and performance through innovative programs and scheduling that meets the needs of diverse learners. Schools with SWSS distinction can innovate without approval from the state as they can ignore the waived portions of Georgia Education Law (Title 20), State Board Rule, and Georgia Department of Education guidelines. Students at FHS may take advantage of the option to matriculate in 4 or 5 courses during the academic school day during their senior year due to SWSS or seek additional opportunities within the traditional school day. The faculty at FHS found many students who did not want to leave school early, but instead, wanted to take more academic courses in their areas of interest necessitating the addition of more diverse course offerings, including more science courses.

In the fall of 2009, as FHS was opening its doors for the first time, a female 11th grade student approached the science department chair with the request to add an additional science course to her schedule. She had already completed AP Biology the previous year and was enrolled in Human Anatomy and Physiology. At the time, the science department at FHS did not offer any additional science courses that would fit into her schedule and so the science department chair created an independent study course for her. She was assigned to a mentor teacher for one period and during that time she worked on setting up and breaking down AP Biology labs along with learning the critical analysis of scientific research through article reviews. She learned to mix stock solutions and to rehydrate enzymes. She also learned how to set up, organize, and maintain a chemical supply closet. She was scheduled during the time that the AP Biology class met, so she was able to assist those students during labs with data gathering and analysis.

Due to this student's success that first year, the science department at FHS allowed her to act as a lab assistant again the following year and word spread about the unique opportunity offered to this student. During the 2010-11 school year, two more students were added to the LAB program. The original student continued to work with the AP Biology program, and the others were assigned to Honors Chemistry and Honors Biology. At this point, job responsibilities were expanded to include preparing samples and specimens and running sample diagnostic labs. These diagnostic labs were performed prior to the class conducting the lab with the goal of identifying any modifications necessary to gather expected data. The members of the science department found these diagnostic labs to be a valuable learning tool for the lab assistants as well as invaluable assistance to the instructor. Interest in the LAB program grew for students and faculty alike.

The LAB program has grown organically in the last nine school years, but the overall goal of offering students' additional opportunities to participate in a more rigorous science curriculum has not changed. Lab assistants have the opportunity to work in all science content areas based on personal interest. From those first years, the LAB program has grown to 49 participants in the 2017-18 school year.

A science department goal for the LAB program has been to increase the number of female lab assistants and to increase the number of female lab assistants declaring an intent to major in a STEM degree program in college (School Improvement Committee, 2015). The *Every Student Succeeds Act of 2015* charges secondary educators with increasing access to and the number of females involved in STEM in order to improve the diversity of the STEM workforce (SCHELP, 2015). The LAB program has the potential to increase the STEM pipeline for females as the number of female lab assistants increased from 1 in 2009 to 38 in 2017. The information in Figure 4 illustrates the total participation of female students by school year for 8 years.

Student Lab Assistant Research Program High School Enrollment		
School Year	Total Number of Participants	Total Number of Female Participants
2009-2010	1	1
2010-2011	6	1
2011-2012	15	11
2012-2013	24	15
2013-2014	33	21
2014-2015	44	32
2015-2016	51	42
2016-2017	52	34
2017-2018	49	38

Figure 4. Female participation in a Student Lab Assistant Research Program at Franklin High School.

Program Goals

Through the LAB, students are able to experience more hands-on science by (a) performing wet labs multiple times during their internship thereby (b) honing lab techniques and experience, as well as (c) increasing participants' critical analysis skills by giving them greater access to lab time and equipment and more one-on-one time with STEM professionals. Lab assistants have opportunities to apply their scientific knowledge in the context of the lab setting regularly. This program continues to offer rigorous opportunities to students interested in science as each participant is encouraged to explore areas of personal STEM interest. Figure 5, Student Lab Assistant Research Program Opportunities, illustrates the overall goals of the LAB program in terms of student STEM possibilities. Environmental, personal, and behavioral variables are considered as key components of the LAB program structure, thus providing students an opportunity to do research in areas that could be potential collegiate STEM majors (see Figure 5).

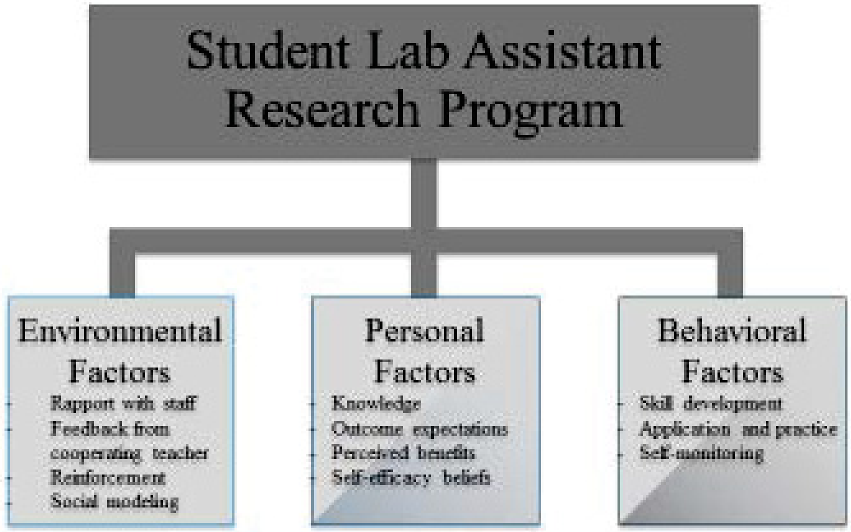

Figure 5. Environmental, personal, and behavioral variables of the LAB influencing female matriculation in STEM.

Recommendations for Implementation of the LAB

Implementation of the LAB at FHS was previously discussed; however, if employed elsewhere, the following information should be considered as recommendations for execution. Suggestions for implementation include starting with a small group of willing mentor teachers. Have science teachers identify potential students who would be interested in the LAB and could benefit from the mentoring relationships offered by participation. By identifying students with need, teachers can ensure inclusiveness of diverse students within the program. As initial lab aides and mentor teachers have rewarding experiences, expand the program to widen the scope of people involved and courses for which lab aides can work. Due to the flexible nature of the program, minimal resources and materials are required. If the school chooses to include evaluation of scientific papers, mentor teachers will need to provide student access to primary literature. This can be accomplished by utilizing the Public Library of Science (PLOS) via the internet.

Willing mentor teachers are the most critical component needed to successfully kick start the LAB. Leaders must promote the LAB by offering literature about the benefits of mentorship and conducting an informational session so potential mentor teachers can make informed decisions about the impact of pre-collegiate STEM programs and understand their roles and responsibilities within the context of the program. Implementers should offer support for mentor teachers through professional learning opportunities. From the beginning, it is important to involve administrators in planning, and clearly lay out blueprints for the program with regards to goals and growth. Additionally, the role of mentor teachers as a support and the role of students as learners should be defined. Plans should indicate potential needs and share expectations for program with all involved parties.

Data Collection Procedures

Data were collected using Seidman's (2006) three-interview series framework. Interviews were conducted utilizing a semi-structured format. Each of the interviews was audio-recorded and later professionally transcribed with prior permission from each participant. See Appendices D and E for documentation about consent and confidentiality of transcriptions.

As described by Seidman (2006), data collection is a process in which the interviewer must plan ahead and be thoughtful about seeking answers to the questions while not "[redirecting] [the] thinking while [he/she] developed it" (p. 25). Instant decisions about direction are required of the interviewer based upon the responses provided by participants (Seidman, 2006). The objectives of each interview must be clear and focused or interviewers run the risk of "imposing their own sense of the world on their participants rather than eliciting theirs" (Seidman, 2006, p. 39). If careful attention is not paid to the interview process, distortion of learned information is assured. Each interview required the interviewer to be prepared, plan ahead, and keep the structural integrity of the interview in mind (Seidman, 2006).

Open-ended interview questions were prepared that are reflective of the framework presented in the literature (Appendix A). Interview questions were designed with environmental factors, personal variables, and behavioral factors in mind as these are the variables indicated in the literature as having an influence on matriculation through STEM degree programs and persistence in STEM careers. Environmental factors include exposure, experiences, and access including STEM program involvement, mentoring, and female role models. Personal variables contain knowledge, expectations, and attitudes such as self-perception, stereotyping, gender bias, and self-confidence/self-doubt. Behavioral factors comprise opportunities for practice and application that incorporate critical thinking, data analysis, soft skill practice, project-based learning, active learning, and real world application. Each of these variables has been identified as impactful facets of STEM programs and linked to increased STEM interest in female students. These variables were considered in the preparation of interview questions.

Interviews were intended to elicit descriptions about the impact of the LAB program on female students' interest and beliefs in STEM without imposing my ideas or words onto the participants. The questions were organized by Seidman's (2006) three-interview series with a clear objective for each interview.

Interview 1. The goal of the first interview was to reconstruct STEM experiences from the participants' earliest memories to the present time. Interview questions were designed to encourage the participants to describe early experiences with STEM including elementary, middle, and high school experiences, as well as LAB experiences in order to reconstruct the life history of each participant. The questions for the first interview were designed to lay the groundwork for understanding the importance of past STEM experiences and their relationship to the LAB.

Interview 2. The goal of the second interview was to explore the details of the participants' experiences with the LAB. Interview questions were designed to allow participants an opportunity to reconstruct the LAB experience with as many details as possible. Interview questions can build upon themselves and can provide additional or unexpected information for the researcher; therefore, it is necessary to be flexible in questioning while still maintaining control of the interview process (Turner III, 2010).

Interview 3. The goal of the third interview was to reflect on the meaning of the LAB to each participant. In order to accomplish this, the first interview and second interview must establish the personal life history with STEM and details of the experience with the LAB so that they combine and merge to create meaning for the participants. Participants were asked questions designed to make intellectual and emotional connections between their work in the LAB and their life.

I avoided “why” questions and instead designed questions that encouraged participants to share their own accounts of the LAB experience. My goal was to ask the same questions of each participant, but “flexibility [took] precedence based on perceived prompts from the participants” (Turner, 2010, p. 255). Interview questions can be found in Appendix A.

After each interview was conducted, I listened to the audio-recordings and reviewed notes, but “[avoided] imposing meanings” until all interview were complete (Seidman, 2006, p. 113). Data analysis occurred at the culmination of the three-interview series. An interview protocol for asking questions and note taking was followed (Creswell, 2009) and reviewed in order to reflect upon the interviews. Notes have been found to be a “very natural and necessary process” during interviews which can then serve as a self-check for misinterpretation or skewing of information later (Corbin & Strauss, 2008, p. 32).

Data Analysis Plan

Audio-recordings of the interviews were transcribed by a professional transcriptionist. This transcription service shortened the timeframe for beginning data analysis and increased the accuracy of the transcriptions. The transcriptionist was required to complete a confidentiality agreement prior to sharing audio files. Each of the participants was asked to provide consent for using a transcriptionist for interview data and a pseudonym was used to label the audio-recordings so the transcriptionist did not know the name of the participant. See Appendices D and E for a copy of these forms. First and last names were never used by the researcher or included in any of the data unless required by the Institution Review Board (IRB) on approved consent documents. All documents will remain in the primary researcher's possession.

In compliance with 45 CFR 46.115(b), all paper records relating to IRB approved research will be retained for 3 years after closure of the project, including questionnaires, consent documents, and transcriptions of digital recordings. These documents will be stored in my safe at my personal residence. The paper documents will be shredded 3 years after the defense of my dissertation in April of 2018. In compliance with Exempt IRB requirements, digitally recorded files of interviews were deleted as soon as transcriptions were verified for accuracy.

In *Phenomenological Research Methods*, Moustakas (1994) described two modified methods of data analysis for phenomenological research: van Kaam and Stevick-Colaizzi-Keen (pp. 120-122). Moustakas' modification of the Stevick-Colaizzi-Keen Method of Analysis of Phenomenological Data guided the data analysis of this study. A copy of the modified steps can be found in Appendix G in order to provide a simplified overview of the data analysis process.

The first step in this method describes the researcher's experience with the phenomenon. Since I had never participated in a student lab assistant research program, this was not part of my lived experience and provided a new area of information to be inspected. The second step of this method consisted of utilizing the verbatim transcript for each study participant to further examine the data. This second step consisted of seven parts itemized as "a through g":

a. Each of the participant's transcripts were studied and considered with respect to significance of the experience of participation in the LAB.

b. All relevant statements were recorded and notable statements marked.

c. Each non-repetitive, non-overlapping statement was listed as these became the invariant horizons or "meaning units of the experience."

d. Grouping and relating the invariant meaning units allowed themes to emerge.

e. Synthesis of units and themes occurred allowing for a textural description of the participant's experience which included the participant's verbatim examples.

f. The textural description was reflected upon and, using imaginative variation, a description of the experience was written.

g. The meanings and essences of the experience were re-evaluated and a textural-structural description was constructed for each participant.

The third step in this process was to use the verbatim transcripts and repeat the process for each of the other participants in the study. The fourth and final step in this process was to construct a composite textural-structural description which combined all of the participants' experiences into a universal description of the meanings and essences which represented the group as a whole (Moustakas, 1994, p. 122) and represent the core themes in the study.

As defined by Moustakas (1994), the investigation of the participants' lived experiences "is derived from first-person reports of life experiences" (p. 84). This investigation followed four steps:

1. Epoché
2. Phenomenological reduction
3. Imaginative variation
4. Synthesis

The *epoché* was the first step in coming to understand the lived experiences of another; it is “the opportunity for a fresh start, a new beginning, not being hampered by voices of the past that tell us the way things are or the voices of the present that direct our thinking” (Moustakas, 1994, p. 85). The researcher must set aside all preconceptions and prior ideas and recognize personal bias, so they can then begin the “process of setting aside predictions, prejudices, predispositions about things” (Moustakas, 1994, p. 85). Only then can a researcher become aware of new feelings and understandings. This is the step where a researcher needs to know and see things free of judgment. According to Smith (2007), *epoché* is:

> Husserl’s basic method or technique for the practice of phenomenology; I bracket, or make no use of, the thesis of the existence of the world around me, and thereby I turn my regard or attention from objects in the world to my consciousness of objects in the world around me; adapting the Greek word “epoché” meaning “to abstain”; also called bracketing. (p. 432)

The next step in the process of understanding is called *phenomenological reduction* (Moustakas, 1994). Reduction involved suspending personal judgement of the world in order to focus on the analysis of the phenomenon or experience. Moustakas (1994) explained it is necessary to “look and describe; look again and describe again; look again and describe; always with reference to textural qualities” (p. 90). Everything not directly relevant to the study must be set aside or “bracketed” so the research process is solely focused on the experience and the questions (Moustakas, 1994, p. 85). The information and reflection on the information is then reduced to textural language so the entire phenomenon can be understood. Phenomenological reduction includes "horizonalization" as new horizons appear following reflection. Initially every statement is given the same value, but overlapping and repetitive statements are then removed leaving only the *horizons* or the "textural meanings and invariant constituents of the phenomenon" (Moustakas, 1994, p. 97). Horizonalization is described as:

> The range of possibilities left open for an object of consciousness, for example possible properties of the back side of an object as I see it and possible relations of the object to other objects; the horizon of an act of consciousness configures the object of consciousness as having possible properties and relations beyond those explicitly presented in the act, properties compatible with the content. The inner horizon is that part of the horizon of an object of consciousness which includes possible further properties of the object, such as the size or color of the back side of an object of vision. The outer horizon is that part of the horizon of an object of consciousness which includes possible further relations of the object to other objects, such as the relation of an object of vision to objects behind it, say, objects that are not currently visible. (Smith, 2007, p. 434)

The third step in understanding the phenomenon was *imaginative variation* in which the researcher looked at the phenomenon from various perspectives and used her imagination to come up with numerous possibilities. Imagination and reflection guided by intuition direct this step of the process. Four steps are followed to connect essence with meaning:

1. Systematic varying of the possible structural meanings that underlie the textural meanings;

2. Recognizing the underlying themes or contexts that account for the emergence of the phenomenon;

3. Considering the universal structures that precipitate feelings and thoughts with reference to the phenomenon, such as the structure of time, space, bodily concerns, materiality, causality, relation to self, or relation to others; and

4. Searching for exemplifications that vividly illustrate the invariant structural themes and facilitate the development of a structural description of the phenomenon (Moustakas, 1994, p. 99).

The last step in the research process was the *synthesis of meanings and essences*. Commonalities in the experiences of the participants were examined. At this point, the researcher must integrate all the descriptions of experiences into a unified essence of the phenomenon as a whole (Moustakas, 1994).

The transcriptions were read multiple times and analyzed following Moustakas' procedure for phenomenological analysis. The analysis began with horizonalization or recognition where every statement made was treated as new and of equal value (Moustakas, 1994). Horizonalizing the data necessitated finding the relevant statements and giving them equal weight. The *horizonalized statements* were used to generate *meaning or meaning statements* which were then *clustered* into common *themes* (Moustakas, 1994, p. 118). Textural descriptions of each participant's lived experience with the phenomenon were developed, then structural descriptions were generated. Combining the textural and structural descriptions allowed for the meanings and essence of the phenomenon to be constructed (Moustakas, 1994, pp. 118-119).

Creswell (2012) stated that data analysis ". . . consists of developing a general sense of the data, and then coding description and themes about the central phenomenon" (p. 237) and described the process as ongoing and continual, necessitating reflection upon information supplied by participants (Creswell, 2009). Miles and Huberman (1994), describe information as "[piling] up geometrically" (p. 55); therefore, a system of organization is required to deal with the quantity of data phenomenological study generates. The *Coding Manual for Qualitative Researchers* by Saldaña (2009) described methods for dealing in mass quantities of data and was used to code the information gathered from the interviews. Saldaña (2009) suggested *theming the data* as a first step to first cycle coding method. This step involves reviewing all of the transcriptions and notes in order to identify predicted and emerging themes. In this coding methodology, themes are defined as "descriptions of behavior within a culture, explanations for why something happens" (Saldaña, 2009, p. 139).

I analyzed the data using a structured coding system laid out in *Coding Manual for Qualitative Researchers* (Saldaña, 2009) which consisted of color coding predicted and emerging themes. This allowed for the creation of categories of data from the interview transcripts. I organized thematic information into Excel in order to manage the vast amount of data.

Yin (2009) reports five specific techniques for analyzing qualitative data but describes pattern matching logic as the "most desirable strategy" (p. 136) as it relies on theoretical propositions. Emerging patterns are compared to predicted patterns based on the theoretical framework of the study (Yin, 2009). Pattern matching was used in this research to compare emerging patterns to those identified as key components of Hackett and Betz's (1981) social cognitive career theory and Bandura's (1986) social cognitive theory.

The predetermined codes identified in the literature review acted as initial themes, and emerging codes were identified during data analysis of interview transcripts. Predetermined codes consisted of personal variables such as knowledge, expectations, and science attitudes, environmental factors such as exposure, experiences, access, norms, and influences and behavioral factors such as opportunities for practice, skills acquisition, and application of knowledge. Saldaña (2009) indicated the qualities of themes are "repeating ideas, participant or indigenous terms, . . . theoretical issues (e.g. interpersonal relationships, social conflict, and control), and even what is missing from, not discussed or present in the data" (p. 143). The themes of this study were a result of coding, categorizing, and reflecting (Saldaña, 2009). The code-to-theory model for data synthesis and analysis is displayed in Figure 6, *Codes-to-theory model for qualitative inquiry* (Saldaña, 2009).

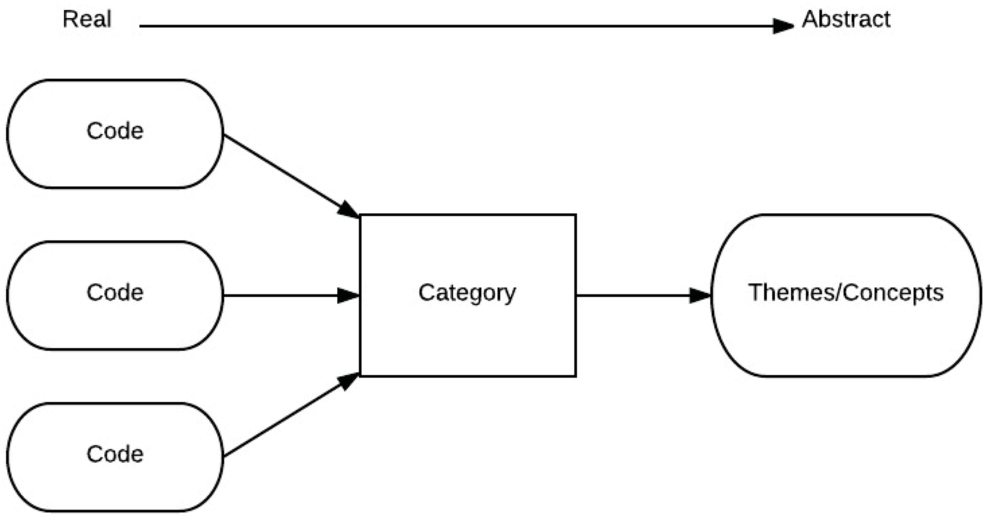

Figure 6. Code-to-theory model for data inquiry Saldaña's (2009).

Credibility

Trustworthiness

Validity and reliability in qualitative studies cannot be addressed in the same way as quantitative and mixed methodology studies (Shenton, 2004). Qualitative researchers often shy away from these terms and instead choose to focus on trustworthiness (Lincoln & Guba, 1985; Shenton, 2004). Trustworthiness is vital in any research study so that the results can be considered worthy of consideration (Lincoln & Guba, 1985). The epoché process leads to trustworthiness and requires that the world be "cleared of ordinary thought and is present . . . as a phenomenon to be gazed upon, to be known naively and freshly through a 'purified' consciousness" (Moustakas, 1994, p. 85). For a researcher, this necessitates emptying the mind of any former influences and "to become completely and solely attuned to just what appears, to encounter the phenomenon as such, with a pure state of mind" (Moustakas, 1994, p. 86). In the study, this will include listening carefully to each interview participant and using verbatim recordings of interviews. I took careful notes during interviews and paid attention to not only the words, but the actions and facial expressions of the participant so as to fully capture the essence of the interview experience.

Lincoln and Guba's (1985) evaluative criteria for establishing trustworthiness in a qualitative study include credibility, transferability, dependability, and confirmability. Credibility is confidence in the truth of the findings, while transferability speaks to the findings and their applicability in other contexts. Credibility paints a true picture of the lived experience of lab assistants who participate in a lab assistant research program. Dependability reports consistent findings that are repeatable and confirmability indicates the degree to which reported findings from the study are due to respondent data and not researcher interest, motivation, or bias (Lincoln & Guba, 1985).

Credibility was addressed through the use of Seidman's (2006) three-interview series technique. The nature of phenomenological studies is to focus on experiences and events which generates rich, thick data. Rich refers to quality, while thick refers to quantity (Fusch & Ness, 2015). Rich, thick description was used to create a paper trail of accounts so that other researchers could replicate the procedures used in this study. The researcher read, read, and reread before culling the data for like phrases and themes. These themes were grouped to form clusters of meaning and from this, a universal meaning of the LAB program was constructed (Creswell, 2013; Moustakas, 1994). By following a specific methodology, dependability was established as there is a paper trail of accountability. Dependability was addressed by use of a professional transcriptionist as this reduced error in interview transcription data allowing for proper data analysis. Confirmability was established as I followed Seidman's (2006) three-series interview protocol which increased contact with the study participants (Lincoln & Guba, 1985). Increased contact allows for the gathering of thick, rich data (Fusch & Ness, 2015) thus reducing researcher predispositions which allowed the focus of the study to be on emergent findings which are the result of participant data (Shenton, 2004).

Transferability was established as appropriate details of the context of the phenomenon were reported in such a way that another person could read the findings of the study and determine whether this phenomenon might be similar enough to another so as to expect similar findings (Shenton, 2004). In this study, descriptions provided offer "sufficient information about the context in which an inquiry [was] carried out so that anyone else interested in transferability has a base of information" (Lincoln & Guba, 1985, pp. 124-125). Credibility and transferability will aid others who read this study to determine whether the LAB program might be a viable pre-collegiate STEM opportunity for female students at other sites.

Gibbs' (2007) procedures for trustworthiness were followed and the accuracy of all discoveries were tested by checking and rechecking the transcriptions for errors, comparing the data with established codes, as well as keeping written notes that contain the codes and their definitions for constant reference. Seidman's (2006) three-interview series ensured lengthy engagement which increased the likelihood of trustworthy findings (Lincoln & Guba, 1985). Additionally, I have spent a number of years teaching high school students and acting as a teacher leader and department chair in a large suburban public school setting. I am an experienced science teacher who has worked with students of all abilities and educators from middle school through the university level. Interviewing students who have participated in a student lab assistant research program was a new experience with no partialities, thus I was in a position of "learning the culture . . . and building trust" (Lincoln & Guba, 1985, p. 301).

Limitations

Limitations are evident in all research methodologies and "study designs are not universal" (Fusch & Ness, 2015, p. 1409). Alshenqeeti (2014), Boyce and Neale (2006), and Seidman (2006) all argued that interviewing takes a great deal of time and money and generates massive amounts of data which can be a deterrent to novice qualitative researchers. Seidman explained interviewing is "especially labor intensive" and requires "support" (2006, p. 12). Having a plan for data collection and analysis and a dissertation committee to support me reduced the impact of these variables.

A limitation of this study is that all of the data collected were gathered through interviews, as this is the predominant data collection method of phenomenological research. Alshenqeeti (2014) suggested since large amounts of data are expected to be revealed during interviews, accounts may be incomplete, and the nature of questioning could lead the interviewee. Incomplete accounting was diminished by meeting with each participant three times thus allowing for time to reflect between interviews and by offering participants a chance to review transcripts for possible error or to add relevant information. By asking open-ended questions, I reduced the impact of the questions themselves. I avoided "why" questions, and instead concentrated on stimulating descriptions through questions that ask the participants to "describe" and explain "how" in order to encourage each woman to relive her past experiences with STEM and with the LAB.

Another limitation in this study is inherent in the nature of the research. The study occurred on one subset of student lab assistants who all attended the same high school. Given the number of female students in the lab assistant program, the data may not be generalizable to all students in the LAB or to all students who may participate in programs like this one at other high schools.

Potential participant selection bias may also be a limitation of this as students who agreed to participate in this study were known to me. These students might have uniquely positive experiences with the student lab assistant program and thus data might only reflect positive experiences and not speak to weaknesses or negative aspects of the student lab assistant program. This was mitigated by asking open-ended questions, encouraging the participants to be honest in their accounts, and by reiterating that their responses will not have any negative ramifications. Additionally, I adhered to bracketing and set aside my own experiences in order to better understand each participants' unique experience with the LAB (Creswell, 2009).

Delimitations

Delimitations are the characteristics of a study that can be controlled. Since each participant was interviewed based upon her participation in a student lab assistant research program, the sample size for this study was small. Due to the small sample size, it is impossible to say with certainty that the experiences presented in this study are typical, but the data presented in this study were not necessarily intended to be generalizable to a wider population. The goal of this work is "particularity rather than generalizability" (Creswell, 2009, p. 193); however, the use of phenomenological methodology assured the study participants' life experiences were presented in their own words. The emergent descriptions from this study were synthesized into a unified description of the phenomenon as a whole. The themes were not ranked and no one statement was given preference or importance over another. As such, the study may serve as an indication of various factors to consider when evaluating an existing student lab assistant research program or for the implementation of a new program.

Protection of Human Participants

Following the ethical principles generated by the Belmont Report (1979), this study 1) did no harm and 2) maximized possible benefits and minimized possible harms (pp. 4-5) by including respect for persons, beneficence, and justice. The principles and rules governing human subject research is described in the Code of Federal Regulations, Title 45, Part 46 (45 CFR 46) was followed. The researcher completed the Collaborative Institutional Training Initiative (CITI) web-based training course, Human Subjects Research (Reference Number 1836438, dated 8/27/2017, Appendix H) and took all necessary steps to ensure the rights of the research participants. All references to the exact name of the school district and high school were eliminated and a pseudonym, FHS, was used in its place. The anonymity of all participants was preserved as a pseudonym was used at all times for each participant Participation in this study was voluntary as described in the Belmont Report (1979) and all participants were assured that all data collected would be held in complete confidence as allowable by law.

I sought and received Valdosta State University's Institutional Review Board approval for my study at a time determined appropriate by my committee members. See Appendix I. Additionally, Appendix E contains a copy of the Research Consent Document that was used for the study. Appendix F contains of copy of the

Confidentiality Agreement for the transcriptionist used for the study. With these measures in place, there was minimal to no risk to any of the participants in this study.

Chapter IV

FINDINGS

For lest it be forgotten, attitudes are enduring while knowledge often has an ephemeral quality. The price of ignoring this simple fact and its implications is the potential alienation of our youth and/or a flight from science – a phenomenon that many countries are now experiencing. There can, therefore, hardly be a more urgent agenda for research (Osborne, Simon, & Collins, 2003, p. 1074).

Introduction

Research results, data analysis, and findings that evolved from data collected through interviewing five LAB student participants who recently graduated from a suburban 4-year public high school in a metropolitan area are presented in this chapter. The interview protocol provided a setting for rich description of how female participants discuss the role of the LAB in their high school experience and the perceived impact of the LAB on their beliefs and interest in STEM. The three-interview protocol developed by Seidman (2006) was used. In the first interview, participants were asked to reconstruct their earliest experiences with STEM up to participation in the LAB and to discuss how they became involved in the program. In the second interview, participants were asked to reconstruct the details of their experiences with the LAB. And in the third and final interview, participants were asked to reflect upon their experience and talk about the impact of participating in the LAB on their current beliefs and interest in STEM.

Participant narratives set the tone for synthesis of a "universal description of meanings and essences which will represent the group as a whole" (Moustakas, 1994, p.122).

A void in previous research and literature explaining the perceived impact of the LAB on female students' beliefs and interests in STEM, as well as a lack of these types of programs in general, motivated my interest in investigating the student perspective regarding the LAB and STEM beliefs and interests. Studying the underpinnings of how female lab aides experience participation in the LAB revealed the importance these students placed on STEM opportunities and influence. A qualitative framework was used to design the study. Methodology consistent with phenomenological research guided data collection and analysis of data. The results are a culmination of the female students' voices and provide a deep perspective into their personal and shared lived experiences with the LAB. In order to study the perceived impact of the LAB, two primary questions and one secondary question established my research framework:

1. What are the perceptions of female lab aides about the impact of participating in LAB on their beliefs and interests in STEM?
2. What do female lab aides perceive as LAB elements most beneficial to their beliefs and interests in STEM? What elements are the least helpful?

   2A. What do female lab aides suggest to improve the LAB and, perhaps, to increase the number of female students interested in collegiate STEM majors?

Overview of Participants

The results for this phenomenological study developed through data collected from 15 face-to-face interviews with 5 participants. Purposeful or criterion sampling helped identify the population for the study and further assured the probability of reaching female students who had been involved with the LAB in high school. Participants were chosen who: (a) had completed two or more consecutive semesters in the LAB, (b) were female; (c) were 18 years of age or older, (d) had recently graduated from high school, (e) were enrolled in a college or university during fall of 2017, and (f) had reported an intention to major in a collegiate STEM degree program. Participants were excluded if their immediate family members worked in STEM degree fields in an effort to eliminate as many extraneous variables as possible outside the LAB experience that impact STEM beliefs and interest.

The sample consisted of five females who were 18 years of age. Four of the participants identified with being White, and one identified with being Asian. Three participants reported being involved with the LAB for 4 semesters and two participants reported being involved 2 semesters. All of the participants graduated from high school during the spring semester and were interviewed during the following fall semester. All the participants were attending a 4-year college or university and all reported a STEM degree major. Only two of the participants reported attending the same college or university. None of the participants shared the same mentor teacher during the LAB experience, which provided for diverse perspectives.

Qualitative inquiry allowed me the chance to engage with the young female students who participated in the LAB as I investigated the phenomenon surrounding how they perceived the impact of participating in the LAB on their beliefs and interest in STEM. The following descriptions are designed to help the reader feel the essence of their stories. In the last interview with each participant, I asked the participants about facets of the LAB that were least helpful and what they would suggest to improve the program and, perhaps, to increase the number of female students interested in collegiate STEM. The participant responses are at the end of each participant's description and are offered as yet another representation of their voice and personal investment in the LAB.

Participant 1 Narrative: Ada-Lived Experience

Biographical information. Ada is an 18-year-old White female majoring in Biology Education. Ada currently attends a large university in a large town with a suburban setting and a commuter campus (College Board, 2018). She is in the first semester of her freshman year in college and was involved in the LAB for four semesters. Ada hopes to become a veterinarian or teach high school biology in the future. Ada described her early perceptions of a scientist as "so cliché to say, probably Einstein" and explains she envisioned "an old White man with frizzy hair." She also stated she "didn't really think about making STEM a career or really focusing on it at all . . . until freshman year of high school."

History with STEM. When asked about her earliest memories and experiences involving STEM at school, Ada reported she never really thought about going into science as a kid. According to Ada, "[her] curriculum didn't focus on science, it was more English and Math" and "science was kind of forgotten about in the mix." She "literally [did not] remember learning science at all until fifth grade." She described having a teacher who was also a practicing vet on the weekends, and he often took them outside and to his farm. The real world nature of this experience resonated with her. Ada attributed her early perceptions of scientists as men to the fact that her only positive STEM experiences in elementary school included a male teacher.

Ada explained her elementary education experience felt much more focused on English and her only real memories of science in elementary school include her fifth grade teacher. She stated:

> It makes a difference when the teacher has passion for what they're trying to teach. So, the fact that we would go outside and learn that way, it showed he actually wanted us to learn in. So . . . I would say that is probably the bulk of where I learned about science. But before then, I don't even remember learning science at all.

Ada further articulated that there was very little scientific experimentation that took place and no STEM opportunities outside the traditional science classroom or the traditional school day.

In middle school, Ada reported not being very excited about science in sixth and eighth grade. Her seventh grade Life Science teacher made an impact because she seemed excited about the content "so, it kind of got [her] into learning about it," but much of her middle school experiences revolved around note taking, paper based assignments, and little to no hands-on lab opportunities. Ada reiterated there was very little experimentation that took place within the school day and no STEM opportunities outside the traditional classroom or the traditional school day were offered or made accessible to her.

Ada's first truly memorable experiences with science occurred in her ninth grade Honors Biology course. After conducting a lab dealing with gel electrophoresis, she explained "I actually saw something, I actually did something, I came to a real life conclusion, and it was the first time I felt like a real scientist." Ada mentioned she had seen lab aides helping to set up the gel electrophoresis lab. Ada went on to explain she had taken many more lab based courses in high school including Anatomy, Chemistry, Environmental Science, and Physics. While Ada appreciated opportunities for hands-on experiences in all her coursework, she preferred the wet lab experiences of the Anatomy and Honors Biology courses.

When asked about her earliest memories and experiences involving STEM at home, Ada explained "[she] didn't have very science-focused parents or siblings" and "science was never pushed in [her] house." She went on to say her brother had a subscription to a science magazine focused on animals which would arrive once a month and "[she] was such a tomboy that [she] just played with all of his stuff." Ada felt supported in anything she took an interest to, but her parents were not science minded and did not implement science in the household. Ada was asked to recall a time when she had seen her parents engage in scientific inquiry and she stated "I don't think I have ever seen my parents conduct a scientific experiment of any kind."

LAB experience. Ada explained that she became interested in the LAB during her freshman year of high school because she saw lab aides coming into her Honors Biology class and assisting with setting up labs and helping out other students during their lab time. Ada described feeling like "[the lab aides] were all, like, a part of this community of science kids in the school," and "[they were] all so passionate about the same thing, and so [it was] kind of like being in a community of people who all want to learn," which was something she wanted to be a part of. Ada went on to say that she had aspirations of being an English teacher prior to taking Honors Biology, but was now interested in Biology Education as a possible career option. Ada felt like the LAB would provide her an opportunity to be immersed in science and teaching and provide her the opportunity to work one-on-one with a female science teacher which could help her decide if Biology Education was something she wanted to pursue.

Ada described her duties in the beginning of her involvement with the LAB as an 11th grade student as “training” duties where she did dishes, managed lab materials, learned lab safety protocols, and put away supplies. She assisted more experienced lab aides with lab setup, but did not complete a lab setup on her own. As Ada’s experience grew, so did her duties. By 12th grade, Ada’s responsibilities included researching lab protocols, troubleshooting lab protocols, running diagnostic labs to get sample comparison data, and setting up lab activities for an Honors Biology course. She assisted her mentor teacher with curriculum design ideas and often troubleshot providing a unique student perspective on understanding. Ada reflected on times where she assisted other science students in lab work using a gel electrophoresis lab to make her point:

> If they needed someone there to be like, ‘hey, it’s ok,’ [and] kind of pat them on the back [and] help them get DNA into their gel, I would kind of help them along with that. That lab kinda stresses people out, so I would stay [in the classroom] and help with that.

Ada revealed that “a lot of the cool experiences that came from the lab aide program were things that [had] to do with the special [education] labs we did.” Ada explained one of her favorite memories from high school was when she and another lab aide took the special education students outside for a scavenger hunt. She explained this opportunity integrated her love of science and her love of teaching.

Because she was involved with the LAB for an extended period of time and because she had acted as a peer facilitator in a special needs class, she was provided a unique opportunity to work with the special education science students at her school. Ada and some fellow lab aides worked to develop ability appropriate lab work for moderately disabled high school students so all students would have access to science at her school. These labs were offered to the special education department once a week and completely run by the LAB students. Ada reflected:

> So I kind of had the leg up of knowing that this person learns better with visual things and this person is blind, so I'll need something [that is] stimulating in a different way besides sight, for him, and that kind of taught me a lot about how to teach different people different things. Which I think is really helpful, not even in the special education department but in education in general. I know that as a kid . . . I learned a lot better [hands-on] and I didn't have teachers that stimulated that sort of learning. So, for me, teaching the [special education] labs taught me how to teach different kinds of people in different ways . . . [They were] easy lessons for me, but I had to [design] it in a way that made sense to a special [education] student, which was the hard part. So, that was a big challenge for me, but it was one of my weekly duties as a lab aide.

Formal assignments for the LAB included a log of detailing daily activities which was submitted once a month. Writing scientific article summaries and critiques occurred and were due quarterly during junior and senior year. Mentor teachers submitted evaluations of student progress. Ada stated that there is a feeling of expectation and there isn't a need to "have your hand held through this program." She said you learn to "do what you need to do, instead of waiting for someone to tell you what you have to do."

When asked about her relationship with her mentor teacher, Ada gushed "[she] is like a second mom," and "she's always there, not even just for [the LAB, but]…she's also there for me personally." Ada explained that her mentor teacher always gave 100%, and it made her want to do the same. Ada indicated that her mentor teacher made her feel like more than just a student.

According to Ada, the LAB "has an air of respect around it," and the principal even knows her name. Ada stated that other students who knew she was a lab aide would come to her for help because they knew she had more experience with science. She also explained that the other lab aides were "always kind of with each other" at school and she "had a great relationship with them." She ate lunch with some of them and celebrated important events such as birthdays, holidays, and college acceptance/denial together during the school day. The LAB provided a network of support.

Impact of LAB. Since STEM activities did not take place during early formal education or at home, the LAB provided Ada with "more immersion into different kinds of science," as well as teaching her about work ethic, time management, focus, and follow through. Since Ada did not have a formal job in high school, she considered her position as a lab aide to be like a job and preparation for college and the work force.

The LAB provided Ada with continual contact with content. She explained the LAB experience gave her skills and knowledge that would transfer to her other courses and other areas of her life. She felt more confident at technical writing and critical thinking as a result of her practice completing scientific article reviews and critiques. Ada alleged the LAB taught her to question, “why does this happen the way that it does or why is that the way it has to be done?” She constantly keeps this in the back of her mind as she approaches all her life choices and feels that “[questioning] is an invaluable thing.”

Ada felt that her most meaningful memories of the LAB were those centered around relationships. She felt like being part of the LAB meant that she filled a role in her school community that was important to her peers and mentors and that she had a purpose. She stated “I [felt] like a real scientist being in [the LAB]” and “I [felt] like I [mattered] to the people I [was] working with in the program.” Ada attributes her interest in science to the teachers she worked with as a part of the LAB and stated “as far as the mentor teacher I had, I would not have gone into science without her.” According to Ada, her friend group outside the LAB was not interested in STEM and neither were the members of her immediate family. The relationships Ada formed as a result of participation in the LAB “impacted [her] for life” as they provided her with positive female role models in STEM and informed her collegiate degree choice as she reported self-efficacy in STEM.

Connections between LAB and life. Ada shared that she still did not feel like a scientist during her sophomore year of high school but something changed along the way. “I do consider myself a scientist, [and] I wouldn’t have said that before high school,” Ada shared. The LAB offered her opportunities to see female science teachers and female science students thriving in areas she had previously thought as exclusively male. During interview three, Ada was asked to reflect on her description of a scientist after having been involved with the LAB. She described:

> And now, the first thing I think of when I think of a scientist is [states the name of another female lab aide], which is really weird. But she, to me, she's just everything I think of when I think of a scientist. She has the drive and the yearning for knowledge that has to do with science. She wants to know more about it, she works as part of the iGEM program, so I have a lot of respect when it comes to her. So she's probably the first person I think of when I think of a young scientist or a scientist in general. She's going to do great things one day.

Having female role models in the LAB enabled Ada to see herself as a scientist. Prior to participation in the LAB, Ada did not see females in STEM often or herself as a scientist. She stated she "never realized there were women in the chemistry field, doing the math-y sciences and the physics sciences." While Ada's experiences in the LAB affirmed her interest in Biology Education, the LAB opened up her eyes to many and varied ways females are involved in STEM. Through her experiences, Ada was able to see how her love of science and helping others could come to fruition by making a choice to pursue a career in STEM. After her participation in the LAB, Ada now feels assured in her experiences and skills. Science is still challenging for Ada as she is unsure of which STEM career path to follow, but being a part of the LAB has given her the self-confidence and scientific skills needed to be successful in a STEM degree major in college as she has logged extensive time in a scientific laboratory.

Suggested LAB improvements. When asked about components of the LAB she felt were the least helpful, Ada stated "honestly . . . I had nothing that was least beneficial about the program" because "[she] came in everyday, kind of learning something." Ada suggested improvements to the LAB should include increasing the number of students who can participate. She proposed that the program continue to grow and perhaps participants could be involved for a longer period of time. Additionally, she stated that more technical writing should be included in the LAB curriculum and scientific summaries and critiques should be due more often during the LAB.

Participant 2 Narrative: Mason-Lived Experience

Biographical information. Mason is an 18-year-old White female majoring in Biological Sciences while attending a large university in a small city with a suburban setting and a residential campus (College Board, 2018). She is in the first semester of her freshman year in college and was involved in the LAB for four semesters. Mason hopes to work in the healthcare field in the future. Mason described her early perceptions of a scientist as “the scientist from [Fantastic Four]” and described him as wearing “a white lab coat,” having “dark hair, and being a “very tall White man.” She also provided an anecdote about an injury her grandmother sustained that “introduced [her] to healthcare” and provoked her interest in pursuing a career in STEM.

History with STEM. When asked about her earliest memories and experiences involving STEM at school, Mason reported, “it was all very basic, and it was mostly geared towards the boys.” Her first experience occurred in “either kindergarten or 1st grade,” and she described a demonstration where her teacher “[put] up a fake volcano . . . and [hit] the start button.” She went on to say that “in those classes, [the teacher] would mostly ask the boys if they wanted to mix things and play with things.” Mason recalled her 1st grade teacher only engaging male students during math games. She went on to provide an example of a 4th grade lab where:

> [The] teacher, she put out um little trays that had different bugs on them . . . and the first thing she said was, I'm going to put bugs out, so boys, if you want to come over to the table, girls if you want to go and play with the dolls, you can because I know how gross it is.

Mason described her elementary STEM experience "very basic" with "pretty much no experimentation" where they "didn't do any hands-on stuff" and stated that:

> Any time [they would] go outside to look at leaves, and [they would] talk about life cycles, it was almost like the teacher was expecting the girls to not want to do it . . . so the girls always had the option to stay inside . . . if we didn't want to go pick up leaves and look at bugs, we could sit in the grass and pick flowers.

Mason did not mention any science involvement or opportunities outside of her school day, so it is unclear if there were no options or if she did not take advantage of them.

In middle school, Mason's earliest STEM memory was a hands-on activity that involved a cow eyeball that she considered a "fake lab" during her Life Science class. According to Mason, "middle school was a lot better than elementary school" as her Life Science and Physical Science teachers were "very unbiased between girls and boys." They participated in "a lot of hands-on stuff" including dissections, physics labs, creating simple machines, and constructing electrical boards. Mason considered these activities "a lot more hands-on" and felt that "[she] actually kind of understood what science was" noting "[her] teacher wasn't telling [her] to go play with dolls." When asked to describe the first time she conducted a scientific experiment, she chose a dissection of a chicken wing that she was assigned in her 7^{th} grade Life Science class.

Mason attributed learning about scientific experimentation and research to her 7th grade and 9th grade science teachers. According to Mason, in 9th grade she began to understand the process and methodology behind experimentation, and "it wasn't so much of a hand-holding experience."

When asked about her earliest memories and experiences involving STEM at home, Mason talked about a microscope she was given as a gift when she was 6 years old. She explained "[she] lived in the woods, and [she] would go find dead bugs or find feathers on the ground and just like look at them in the microscope." Laughing, Mason recounted a time where she "made [her] mom get [her] a circuit board in a box, and [she] tinkered around with it, kind of built it, [and] kind of started a fire." Mason felt increasingly supported by her parents as she became more serious about a possible career in healthcare, and considered herself "independent" and someone who "[does her] own thing." Her mother was a preschool teacher, and there were times science would be discussed at a preschool level, but overall her parents were not science minded and did not implement science in the household. Mason also mentioned a time of economic hardship for her family and her decision in middle school to choose to pay for extra lab fees instead of extracurricular cheerleading. She stressed that her parents always made sure she had a "choice in what [she ended] up doing."

LAB experience. Mason explained that she became interested in the LAB during her sophomore year of high school. She had formed a relationship with her Healthcare teacher, and her teacher "encouraged [her] to do it [as] she thought [Mason] would be a good fit for the Healthcare class." The teacher brought Mason an application at which point Mason "read it and was like, this seems cool."

Mason's daily activities in the LAB included self-directed tasks such as taking it upon herself to assist other Healthcare teachers besides her mentor teacher if they needed help. She spent time demonstrating how to use models and dummies, and teaching younger students in the Healthcare classes. She recalled an instance where her mentor teacher approached her and asked her to teach the students how to draw blood using a prosthesis. According to Mason she "walked them through the process . . . showing them what [she had] learned." She recounted that she often taught younger students "how to do Cardiopulmonary Resuscitation (CPR), how to do the Heimlich, [and] how to put on personal protective equipment." She often reviewed information for her mentor teacher to aid in activity development and evaluate assessments. Mason provided a unique student perspective as she "had gone through the pathway . . . had learned all this stuff . . . and [she] had been exposed to [Healthcare] for 2 years." Her work was also interdisciplinary as she was a Healthcare lab aide, but would often work in a Chemistry or Honors Biology class if she was needed. She often used her interdisciplinary knowledge to try to help her mentor teacher develop and troubleshoot lab activities. Mason recalled one instance during her junior year where she and her mentor teacher developed a lab centered around dissolving bones and Mason used her knowledge from AP Chemistry to explain to her mentor teacher that she would need to remove the lid overnight so pressure would not build up and cause the container to explode.

Mason was also responsible for completing "monthly lab aide logs where [she] . . . said what [she] did day to day." According to Mason, her mentor teacher often offered her opportunities to teach certain content to the classes she lab aided for because she "felt like it was better to hear it from someone who had gone through it and was . . . getting certified and was closer to their age[s] than having a teacher lecture to them." Mason also explained, "[her friends] felt comfortable asking [her] questions." Mason revealed that the LAB was her "favorite thing [she] did in high school" as it provided her with opportunities to apply her scientific knowledge beyond a traditional science classroom.

When asked about her relationship with her mentor teacher, Mason said "we were very close" as they spent substantial amounts of time together, including outside of her assigned LAB time when Mason would "just sit in her room." She described her mentor teacher as "really a big guiding factor in [her] life." Mason's mentor teacher helped her "with college applications" and "helped [her] through her internship" when she struggled. Mason's motivation gained from relationships made through participation in the LAB provoked her to be involved in other STEM oriented organizations like HOSA and the Healthcare pathway. According to Mason, "because of how close [the LAB] allowed [her] to get to know [her mentor teacher], it made [her] drive in HOSA Healthcare organizations so much stronger." She was able to apply scientific content in new ways as she interacted with her mentor teacher and Mason's self-confidence increased as she articulated feeling supported in her growing interest in STEM coursework.

According to Mason, the LAB allowed her to "[get] to know all the science teachers." She felt comfortable interacting with the teachers in the science department and was confident working in different classrooms and gathering supplies from different faculty for labs. Mason "[felt] like being a lab aide gave [her] a relationship too . . . one spot into the community." Within this community, Mason also had friends in the LAB who were interested in Healthcare, some whom she had known since elementary school.

Impact of LAB. In stark contrast to her early childhood experiences with STEM that were described as "basic" and "geared towards the boys," the LAB provided Mason with a "full view of healthcare, and of what [she] was learning, and what [she] wanted to go into." Mason suggested that the LAB provided meaningful real world experiences that informed her choice to pursue a degree in STEM. According to Mason she "struggled" to learn many of the concepts in her science courses, but "learning . . . and then to go back and teach [other students], it kind of gave me that like yes, you actually have learned something." Through her exposure to the LAB, Mason acquired knowledge and the skills to learn difficult content. Her exposure to the LAB also produced a feeling of affirmation and the self-confidence to attempt to learn similar difficult content in the future. According to Mason, "[she didn't] think there was ever a day in lab aiding where [she] didn't learn something."

Mason felt that the LAB had a profound impact on "a very personal level" by providing her "relationships with teachers that [she didn't] think she would have had otherwise." According to Mason, "Having those mentors there as [she] was going through high school [and] applying for colleges" was "incredible." She also insinuated that her mentor teacher helped her through some difficult personal matters during her junior year of high school. She stated she was "so thankful" for the guidance she received and said her participation in the LAB helped her realize that she didn't "just like healthcare" she "[loved] it" and wanted to pursue teaching others about Healthcare too. Mason described "spending so much time with healthcare professionals . . . really taught [her] what [she] wants to do with [her] life."

The LAB also helped Mason realize the interdisciplinary nature of STEM. As a Healthcare lab aide she noted "[seeing] all these different fields coming together [which] gave [her] a better understanding of [Healthcare]." She also attributed her understanding of the different roles one can play in the Healthcare field to the LAB. According to Mason:

> [She] thinks being a lab aide . . . taught [her] . . . [she doesn't] have to go and be a doctor or a nurse, [she] can go in and be an educator in healthcare or, [she can] do both . . . it kind of opened [her] eyes and also showed [her] how many people are excited to do science.

Connections between LAB and life. When asked if she considered herself a scientist, Mason shared that she is "working towards that." She believed that because of her involvement in the LAB she "[has] the skills to actually do [science]" and that she needs to engage in more self-exploration to find her place in science and "develop [her] own thoughts." The LAB exposed Mason to female science professionals including teachers and guest speakers involved in the healthcare field who were successful in areas she had previously considered male. According to Mason she "never realized how many women actually are . . . so involved in science" and:

> Seeing how many . . . who are so enthusiastic . . . whether it be a nurse or a doctor or someone from the lab or a coroner, and just like the way that they're able to talk to kids and say "hey guys" this actually is an option, this is what I do. I think it's so cool to see how many women there are, that it's growing.

Mason felt females could provide a unique skill set to the STEM field because they tend to be "a little bit more intuitive and traditionally speaking more . . . caring." She felt because of this, women may be able to "[take] science from being something people perceive as being hard and cold . . . and [bring] that second layer of actually being a human." When asked to describe who she currently envisioned as a scientist, Mason revisited the idea and stated:

> This might sound kind of weird, but I don't have a picture of one in my head anymore. Just because, I've seen chemists who've worked with beakers, and they almost look like a traditional scientist, but I've also seen ecologists who go out in the field and look at trees and they're wearing like running shorts and a t-shirt. Physicists who sit in front of a blackboard and write a whole bunch of stuff I don't understand. So, I feel like [participation in the LAB] took away the perception that I had and instead of putting a different one in place, [my experiences] kind of opened my eyes [to] how much science is.

The LAB experience provided Mason with opportunities for real world application in Healthcare sciences and affirmed her knowledge of the content. Additionally, the program increased Mason's self-confidence in science and decreased her self-doubt. Prior to high school and participation in the LAB, Mason felt like:

> I was . . . almost scared to go into an honors class, because for most of [prior schooling], it was so geared towards the boys, and I just had this idea that it's just so hard. You're never going to be able to do it, it's too hard.

Mason now feels ready to tackle a STEM major in college and looks forward to the challenges a college education will bring.

Suggested LAB improvements. Mason stated "I don't think there was ever a day in lab aiding where I didn't learn something," but she would like to see the LAB grow and have more science mentor teachers involved. She feels the relationships she formed as a result of participation have changed her perspective about females in STEM and guided her future career path and goals. She would like to see more people have this opportunity.

Participant 3 Narrative: Nina-Lived Experience

Biographical information. Nina is an 18-year-old Asian female majoring in Neuroscience and Chemistry while attending a medium sized university in a very large city with an urban setting and a residential campus (College Board, 2018). Currently, Nina is completing her first semester of college as a freshman. She was involved in the LAB for four semesters. She is in the first semester of her freshman year in college and was involved in the LAB for four semesters. Nina hopes to become a medical doctor in the future. When speaking with Nina about her early perceptions of a scientist, she laughed and described a man who was “Einstein looking . . . mixing different chemicals together and watching them fizz up.” She also indicated she felt she “got the opportunity to do a lot more science than other students.”

History with STEM. When asked about her earliest memories and experiences involving STEM at school, Nina described her involvement with a pre-STEM program called Talented and Gifted (TAG) which began in the first grade. She explained that the program was only accessible to students who were recommended by their teacher and who scored high enough on an entrance exam to be admitted into the program and also iterated that students were required to retest each year to stay in TAG. According to Nina:

> Every week we would meet with our TAG friends, and we would have a seminar class where we did different kinds of experiences or covered different areas of

> STEM not only in the lab but also engineering and um social sciences and epidemiology . . . that we could understand at a younger level.

She remembers making “little concoctions” and doing “little labs” that helped engage her interest in science. The hands-on application of these experiences resonated with her. Nina attributed her early exposure to STEM to being a part of the TAG program and recognized that she “got to do a lot more than other students.”

Nina explained her elementary education experiences with STEM felt like an “every Friday” event when she was pulled out for TAG. The TAG students were separated from the rest of the class and they got “special teachers” and were provided an opportunity to learn “not just out of the textbook.” Nina did not recount other scientific exposure outside the confines of the program during elementary school aside from a moon project in fourth grade.

In middle school, Nina reported her experiences were more “structured” and “more traditional.” She explained most of her STEM experiences “[weren’t] . . . exploring different layers of science,” but instead followed a strict prescribed curriculum where “every day was the same thing.” Her seventh grade Life Science teacher required participation in the science fair which was a welcome change for Nina and taught her the basics of scientific methodology, but much of her middle school experiences revolved around paper based assignments with little hands-on lab opportunities or real world application. Nina shared there was no access to extracurricular STEM opportunities in middle school.

Outside of the TAG program, Nina’s first truly memorable experiences with science occurred in her ninth grade Honors Biology course. She described it as a “completely unique experience” compared to what she had become accustomed to in a science class. While Honors Biology required more work than what she had become accustomed to, Nina appreciated that the content was more challenging and her teachers were more “involved.” She remembered her courses in high school teaching her about the real world applications of scientific experimentation and recalled feeling like “[she was] learning things more advanced than other fellow people were learning.” Nina went on to explain that she had taken multiple lab based courses in high school including Advanced Placement Biology. While Nina appreciated the real world skills she gained in all of her courses, she noted Biology as her favorite course.

When asked to recall her earliest memories and experiences involving STEM at home, Nina explained that her father seemed to like technology and her mother “just supports everything that [she was] interested in,” but she “didn’t have a huge science base at home.” Nina explained that her version of science at home included some kit based science activities and visits to the library for science books. Mostly she remembered “[making] a huge mess” using the at-home science activities, which did not meaningfully impact her science education. Nina felt supported in her growing interest of science as her parents “were always willing to listen and support [her],” but they were not science focused and science based activities outside of watching science oriented television shows were not the norm in their household. Nina explained that her parents “didn’t really introduce science [to her] . . . they didn’t know anything about it.” Nina was asked to describe a time when she had seen her parents engage in scientific inquiry and she laughingly said that she joked with her mom about her cooking being a science experiment, but “there wasn’t real major science going on in the house.”

LAB experience. Nina recounted that she became interested in the LAB during her freshman year of high school because she witnessed lab aides helping science teachers set up labs for her Honors Biology class. She had also heard about the program from some older students she knew. Both the student aides and their mentor teachers seemed interested and invested in their work. Nina stated that she was becoming interested in science again and wanted an "opportunity to do a lot more." She felt participating in the LAB would provide her the opportunity to be immersed in science and gain skills unique to someone her age. She also felt the skills gained from participating in the LAB would be transferrable to other settings and "[could be used] for [her] other classes."

Nina described her primary LAB duties as lab set up and take down as well as assistance during lab work when the schedule permitted. She also shared that "duties [varied] from classroom to classroom," and that if she was helping a different teacher, she could be doing something entirely different pertaining to the content area. Nina stated "if a student asks a question, then we are able to answer them." Brainstorming labs, troubleshooting materials, and helping plan labs and lectures were also mentioned as LAB duties. Nina mentioned handling lab equipment and learning their proper names and uses. "I've had practice…in handling lab equipment; I know what the things are called, their proper names and proper uses." While initial placements in the LAB are based on student interest and abilities as well as willing teacher participants, Nina explained that each lab aide "can move around if other teachers need help" offering the opportunity to work in multiple content areas and work for different mentor teachers.

By senior year of high school, Nina's responsibilities increased. Her mentor teacher was newly teaching Advanced Placement Biology, and Nina often helped her troubleshoot the lab protocols and run diagnostic labs to get comparison data. She also assisted her mentor teacher with the multiple step lab preps that came along with many of the required course lab work. Nina said:

> You kind of get behind the scenes action, [which] is really helpful for the both of us, for the teacher and the student because the teacher gets a second set of eyes on their material. Would their students understand it? It's a better perspective, almost. And then the student, of course, gets a lot of help because they get to see what the teacher is doing and get a different understanding of the classroom setting.

Due to Nina's extended involvement with the LAB and her interest in interacting with the less experienced lab aides, she took on an informal leadership role in the program her junior year often acting as a mentor to lab aides with less experience. Because of her interests, the LAB coordinator asked her to consider acting as the Head Lab Aide her senior year, an honor bestowed upon someone who has both intelligence and leadership abilities. Helping disseminate information about the program, coordinate schedules and events, and act as sounding board for her peers ranked highest among Nina's duties.

Assignments for the LAB included a detailed log of Nina's daily activities which she submitted once a month. She thought this "[was] a good way to keep up with what [she was] doing for the teacher," and "[she looked] back at that log when [she] was a lab assistant for the second year in a row to kind of figure out what [she] did around that time last year." Nina spoke about having to write scientific article summaries and critiques saying "these [were] really interesting assignments that [she] would not have had a chance to do if [she were not] a lab assistant." During further discussion, Nina explained that each lab assistant chose their own peer reviewed scientific article based on their own interests to analyze, summarize, and critique "like a real professional would do in the real world" if he or she was conducting his or her own research.

When encouraged to describe her relationship with her mentor teacher, Nina said excitedly she "was lucky enough to have had a really close relationship with her," and involvement in the program provided an opportunity to have a "one on one relationship." Nina further described their relationship as a "close bond" and a "close experience" where she felt she could always ask her mentor teacher for assistance or advice. She explained that her mentor teacher was there for her when she needed it, and she made her feel like more than just a student. She felt the close teacher-student bond provided a new perspective into her approach to her STEM coursework and the scientific community.

As stated by Nina, the LAB has its own "program society." Nina explained that other students who knew she was a lab aide would come to her for help with science specific questions and questions about science courses. She knew all the science teachers in the department by name and since she was a lab aide during the department's common planning, it was not uncommon for teachers to "pop in and say hi to [her] since [she] was involved in the science community at [school]." In addition to her day to day encounters, Nina spoke to her relationship with former lab aides:

> Past lab aides would tell me about what they [were doing] in college, [which] I now utilize in the lab. I'm also looking into being a TA as well. [It's] really interesting, a lot of the lab aides have done that as well [as a TA in college] and they really enjoy it. So [the LAB is] a really good community and exposure, and

> you have those connections, and you know those classmates forever…you can always reach out to them, reach out to people who have already matriculated into college and they can help you.

Impact of LAB. According to Nina, her participation in the LAB allowed her to learn and practice invaluable communication skills. Nina clarified that courses are taking place during the time that lab aides are scheduled for their LAB class period, so often classes are in session while the lab aides are with their mentor teachers which necessitated a certain amount of communication. She felt like her opportunities to communicate with staff and her peers were paramount to her education. In reference to communication:

> [The] lab assistant program really helps you build upon that and you get this fresh set of experiences that [are] constantly building that real world application, those real work skills that you need to be able to talk to other people. Not just performing well in a classroom, so that experience is the most beneficial part of the program.

Nina had access to positive STEM experiences during her elementary years, but middle school created a gap in both experiences and interest. While Nina's parents were more than happy to support her endeavors, science was not a priority in the home. Nina was interested in science prior to her involvement in the LAB, but her participation in the LAB provided her with "a broader perspective" and an "outside of the classroom, but . . . still in the classroom" experience. The LAB is "more hands-on than a classroom" and "changes the way you approach science." Nina explained, "getting that extra time during school hours to be a part of the science classroom setting, if that's something that you're interested in, that you love, that's always beneficial."

The LAB provided Nina with not only science content, but opportunities to connect with likeminded peers and mentors in science. Nina became a part of a science community and formed unique and special bonds with her mentor teacher. She reported the LAB experience gave her real world skills and lots of practice that will transfer to her other courses and college. She felt more confident in her science abilities and "[does not] know what she would have done without [the LAB]." She feels proficient at technical writing and critical thinking. Nina believes that the extra lab exposure and skills she has gained by being a part of the LAB will serve her well in the future.

Nina explained her most meaningful memories of the LAB were those centered around the community she became a part of as a result of participation in the LAB. She reflected on the social and academic challenges of typical high school students and stated in the LAB:

> Everyone [that is] in it fits in because [that is] what it is, [it is] a program for people like me who want to do stuff in science and teachers help facilitate that. [It is] an amazing program. And I really loved it.

Nina attributed her to the teachers she worked with as a part of the LAB and stated "[they are] super relatable and super fun to talk to." She also expressed the program helped her grow up and made her feel confident that she could choose a hard STEM major in college and be successful. Consistent application of scientific content through daily science laboratory work and the confidence Nina's mentor teacher instilled in her through their daily personal interactions made Nina efficacious in STEM.

Connections between LAB and life. To Nina, a scientist is still a person in a lab, but somewhere along the way she stopped "[distinguishing] between guys and girls." She reflected on her past imagery of a scientist and noted that she used the word 'he' a lot and always pictured "a crazy Einstein looking dude in [a] classroom." Now Nina is "thankful for [having attended] a high school where girls dominate the science field."

During her high school experience, exposure to science by female science teachers had a significantly positive impact on Nina and "really helped [her] love science." Her female science teachers "boosted her morale" and she "didn't really pay attention to gender as much." According to Nina:

> Having a female role model really helped [her] pursue what [she] wanted more than a male role model probably would have, because [she sees herself] in that role, almost. So [she thinks] females in science should be more prevalent. Especially as to younger students, who grow up thinking of a male scientist in the lab. Seeing a female scientist probably would have helped them become more confident, more interested in the subject area.

Having female role models in the LAB enabled Nina to see herself as a scientist. While Nina's experiences in the LAB confirmed her interest in biological sciences and healthcare, Nina now has an interest in adding a teaching component to her studies and would like to one day teach students the way she was taught. Additionally, she feels up to the challenge of majoring in what she considers a "hard major" in college explaining neuroscience as "very intensive."

Suggested LAB improvements. Nina suggested each lab aide's experience with the program might depend upon where and with whom the participant was placed. Since every mentor teacher and every science class offered a different experience, some lab aides might have more positive experiences as compared to others. Nina believes improvements to the LAB should include more opportunity to match like-minded people, so everyone would have an equally positive experience. She also proposed that the program coordinator should reach out to other schools and continue to grow the LAB. She would also like to increase the frequency of technical writing by way of additional scientific summaries and critiques as Nina reported the usefulness of being able to analyze primary literature when majoring in a collegiate STEM degree program.

Participant 4 Narrative: Stella-Lived Experience

Biographical information. Stella is an 18-year-old White female majoring in Biology and Secondary Education while attending a large university in a large town with a suburban setting and a primarily commuter campus (College Board, 2018). She is in the first semester of her freshman year in college and was involved in the LAB for two semesters. Stella aspires to teach Biology at the high school level in the future.

Stella's early perceptions of a scientist were "stereotypical." She mentioned "Albert Einstein" and described a "man with a lab coat and crazy hair and test tube in hand." When asked about her early recollections involving STEM, Stella described a trip with her mother to an Egyptian exhibit when she was about 9 years old. She became interested in archaeology and wanted to "be the first person to discover Cleopatra's lost body." She later recounted a trip to the zoo with her mother where she was exposed to a sick animal. Stella remembered being upset about the sick animal and became interested in trying to fix the problem, telling her mother "I'm going to help it, mom."

History with STEM. When asked about her earliest memories and experiences involving STEM at school, Stella spoke about her 4th grade teacher who "would do so many labs." According to Stella, "every time [they] learned something different, [the teacher] had something physical for [them] to relate it to." She went on to say that they learned about "physics and gravity" and described a lab in which they were responsible for building a structure to protect an egg that was dropped from a ladder. Stella felt "[those] labs were so memorable" and remembered thinking "oh this is so cool, I love this." Prior to this experience, Stella lacked exposure to science within the school day. According to Stella, in her elementary classes, there was "nothing really memorable until fourth grade." She also noted that lab activities were "more of a group effort" instead of individualized work.

Stella described her middle school STEM education as "nice." According to Stella, middle school was "more life science related" and "less lab involved and more concept involved." She spoke about her sixth grade science class having a "large impact on [her]." While she felt she did not retain what she learned, she remembered "having so much fun in that class" and that her teacher was "super encouraging." Stella went on to describe her seventh grade teacher who used music association to teach her students. According to Stella "listening to . . . a teacher rap is . . . the greatest thing . . . so that class really stuck with [her]." Stella expressed interest in musical theater and felt that the material resonated with her because of this shared interest in music. She also described her first dissection of a frog, stating "all the other girls were like 'ewwww,' and [she] was like, yes, I'm ready." Eighth grade was not memorable.

Stella recounted her first truly memorable experiences with scientific experimentation occurring in her ninth grade Honors Biology course. She described her involvement with gel electrophoresis as her first “official scientific lab,” explaining that this lab was a true experiment because of its hands-on nature. Stella attributed its value to her participation in “data taking” and “using other machines” to complete the lab. She also credited her Honors Biology teacher with teaching her about scientific investigation. Stella went on to explain that she had taken other science courses in high school that were lab intensive including Anatomy, Chemistry, Environmental Science, and Physics. Testing solutions for copper in Chemistry and participating in dissections in Anatomy resonated with Stella.

Stella described STEM at home as “mostly academic” and stated, “any time . . . science would be brought up at home, it’d be [her] studying for the classes that [she had] at school.” Outside of the early childhood experiences she had with her mother at the zoo and the mummy exhibit, Stella only spoke about one humorous anecdote involving her mother and the interaction of nonprescription medications. When asked if she had ever engaged in scientific inquiry at home with her parents, she replied, “I can’t think of a particular instance where my parents [conducted] scientific experimentation, unless you count Googling types of over the counter prescriptions to see if you could take Mucinex with NyQuil.”

LAB experience. Stella explained that she was exposed to the LAB her freshman year because of the lab aide in her Honors Biology class. She saw him assisting her teacher and thought “oh that’s so cool,” and wanted to experience being a part of the program. After this encounter, her Honors Biology teacher approached her to tell her she could apply for the program if she was interested and she thought “oh my god I’m so excited . . . this is what I want, I’m super excited.” By her the end of her junior year, Stella was ready to officially apply to be a part of the LAB her senior year. According to Stella, many of her extracurricular classes were used with “musical theater stuff such as acting and chorus and drama classes,” but she made the LAB a priority in her schedule her senior year because she felt like the experience would be worth prioritizing.

Sella described her duties as a lab aide as “preparing lab materials” and refreshing used materials for the next lab which included “disinfecting the test tubes or disinfecting the tables after [they] had organs on them.” She also managed other lab materials and distribution to students. She was responsible for writing lab aide logs which documented daily activities and were submitted monthly. Other assignments included research and writing scientific article summaries and critiques where she evaluated and “[interpreted] from the data” in the literature while applying concepts learned in the LAB and other science courses. Stella considered “learning new types of materials to use” and the opportunity to “interact with teachers on a different level” as some of her “biggest take-aways” from the LAB.

Stella felt her relationship with her mentor teacher provided her a unique viewpoint. She stated that it made her happy to learn meaningful skills and learn about science and the teaching profession. She described her experience as “getting the inside glance.” She was also able to see firsthand how her mentor teacher balanced her career and family. According to Stella she “[thought it was] so awesome because . . . she’s balancing her kids and her teaching” and “she’s such a good mom, too.” Stella noted being impressed by the balance she saw in her mentor teacher's life. She also stated she formed relationships with other mentor teachers and would now consider them friends.

Stella considered the LAB community "distinct and unique" noting she felt honored and proud to be a lab aide. She was thrilled to be a part of something that was recognized by both administration and the student body stating "[she] loved that feeling of saying [she was] a lab aide." Stella also described forming a relationship with another lab aide and said it was "nice and refreshing because she had been an official lab aide longer than me . . . [so the lab aide] had some new insights."

Impact of LAB. Stella emphasized the unique opportunities the LAB presented her to have access to real world science. She felt she had gained skills that were applicable at the college level. According to Stella, this experience "opened [her] up to things [she] would not have gotten access to . . . and that also opened [her] up to things that [she wanted] to further use in college." Stella was able to further pursue her science interests within the context of the LAB as it provided an "out of the box" experience as compared to the "stereotypical Biology, Chemistry, and Physics" classes. Per Stella, she was able to "dive into a further branch of a subject that [she loved]." According to Stella, "the lab aide program has such a unique way of connecting students to the subject that it really [allowed them] to dive further into the subject." Stella enjoyed being able to pick [her] own "articles for scientific reviews" and being challenged to narrow down the number of possible options. Stella gained valuable writing and evaluation skills as she annotated scientific articles to focus on key information and learn unfamiliar vocabulary. She learned to summarize the content, while also interpreting the results, and thinking critically about the scientific methodology and implications. According to Stella:

> [One is] lab aiding for a specific subject, but the fact that the program opened it up to literally anything you wanted to and said you go do you, you write the critique, it was kind of like an endless possibility type of thing. I thought it was so cool and it was one of my favorite parts of the lab aide program, doing the research to figure out what interested me. I loved what I settled on. I thought it was so cool and interesting.

Collectively, Stella described her most meaningful memories of the LAB were those rooted in the relationships she formed. She spoke about the "importance of a female role model in science" and stated:

> All of these women that [she has] been able to develop relationships with and who have said 'if you ever need any help, feel free to contact me,' they just make me feel so much better about going and pursuing a subject like this. Because I feel more confident and I feel more secure I guess, in a subject like this. You literally have no idea what you could be going into, because there's so many possibilities, so it's comforting to know that those women went through the same thing.

Stella believed her mentor teachers "inspired" her education. She described her teachers as "passionate about what [they're] teaching" and their passion being "contagious." Stella recounted a conversation with one of the female teachers in the LAB, telling her "[she was] such a homie" which she considered "a weird word to relate to a teacher, but she's so relatable with students . . . I felt the impact of [her] teaching." She also insisted "relationships that [she] has been able to establish . . . have inspired and shown [her] ways of how [she] can achieve [her goals]." Stella values the advice she received from her mentor teacher as well as her "ability to have someone in that profession look out for you." She described her relationships as "comforting," "super important," and "a whirlwind of help." Stella also stated receiving advice from her mentor teacher helped her in her future plans because she had insight regarding college programs.

Connections between LAB and life. When asked if Stella now considered herself a scientist, she affirmed "yes, [she is] a scientist" as she felt that "anyone who's willing to ask questions and actually go pursue them" is a scientist and that "based off that definition, [she is]." The LAB offered Stella opportunities to a variety of science teachers and students conducting diverse types of experiments in multiple science disciplines. Stella attempted to explain her perception of a scientist as she currently sees one explaining:

> I think of anything honestly, I can think of anything and be like there's a scientist for that . . . I'm sitting here in this coffee shop and I'm looking at paper, and I'm thinking trees-scientist . . . Because I've learned so much more about the types of scientists and the type of sciences in general, and that almost anything that we have or moves or exists in some way related to science. And I think that's super cool because no matter what you're interested in, ever, there's some sort of science that can relate to that . . . I think it's the most relatable subject to life.

As Stella was exposed to female scientists and mentors through the LAB, her perceptions of females in STEM changed. Stella was able to view herself as a scientist after these experiences and according to Stella it "[baffled her]" that there are fewer females than males in STEM outside of schools. She felt as a participant in the LAB "you get a glimpse in this lab aide program, there are more [women], and it just goes to show that these kinds of programs are helping women to love the subject more."

Stella also believed she gained real world experiences through the LAB that have broadened her perceptions of STEM and influenced her choice to pursue a career in STEM. She now feels science is everywhere and for everyone explaining "if [young women are] trying to find something in [science] that they love it's impossible not to, because if they love something they can relate it to science." The possibilities in STEM are limitless in Stella's mind. She had the ability to relate science to real world concepts which she attributed to her participation in the LAB stating:

> The LAB program in general has just shown me that there's more possibilities in science than you think. Because I feel like when [someone hears] you're majoring in science, they're like 'oh biology, chemistry, or physics.' And there's so much more than that . . . And I feel like maybe if people realized the branches [of science], they'd be able to find something that they [related to] and love because no matter what . . . science is literally involved in everything. I feel like something that you love relates to science.

Stella feels she is ready for the challenges of a STEM degree major in college and is excited to pursue her interests in both Biology and Secondary Education.

Suggested LAB improvements. When asked to describe components of the LAB that were least beneficial, Stella stated she "[couldn't] think of anything" as nothing about the program has not worked for her. Stella suggested improvements to the LAB should include more opportunities for lab aides to work with each other under the same mentor teacher within a class period. She explained some of her most meaningful memories of the program included working with other lab aides as this created an opportunity to share new ideas.

Participant 5 Narrative: Stephanie-Lived Experience

Biographical information. Stephanie is an 18-year-old White female majoring in Biology while attending a large university in a small city with a suburban setting and a residential campus (College Board, 2018). She is in the first semester of her freshman year in college and was involved in the LAB for two semesters. Stephanie hopes to study disease pathology in the future and possibly pursue a career in healthcare. Stephanie described her early perceptions of a scientist as "Albert Einstein, who is like the main scientist," and recounted a time her dad dressed up as a "mad scientist with a crazy silver wig and a lab coat" for one of her birthday parties. According to Stephanie, she was never interested in science during her childhood.

History with STEM. Stephanie explained prior to fourth grade, she could not recall much of anything dealing with science. Her experiences were hands-off and textbook based. She described her earliest memories and experiences involving STEM at school as "boring" and "textbook science." Her elementary school curriculum did not emphasize science.

According to Stephanie, her mother volunteered to help with a pH lab at school during fourth grade and that memory resonated with her. She thought "it was cool to see her mom" at school and remembers feeling "supported in science." In fifth grade, Stephanie was placed in what she called an honors science class where she recalled her exposure to science as "a little more experimental." Overall Stephanie recalled her elementary experience as "really boring, like textbook science, so [she didn't] remember a lot of it." Stephanie did not mention STEM opportunities outside the traditional classroom or the school day aside from one science themed birthday party.

Stephanie's middle school years did little to improve her attitude about science. While Stephanie enjoyed her sixth grade science teacher, remembering having had some opportunities for application, overall she felt her other science teachers were "boring" and it "made [her] not interested in science." She still thought "[science] isn't interesting" and "[science] isn't cool." She explained that she did not want anything to do with science and had every intention of exploring fashion marketing once she got to high school.

When asked about her high school experiences with STEM, Stephanie exclaimed she entered high school "science dumb" and still "[wanted nothing] to do with it." Stephanie's first legitimately positive experience with science occurred during ninth grade in her Honors Biology course. She reported the course was difficult, but she understood the relevance of the course. Stephanie stated the class was "a harder class . . . [but] . . . so interesting." Stephanie went on to take Environmental Science and recalled it was applicable to the real world and involved talking about current issues in science. Stephanie reengaged with science for the first time since sixth grade. Stephanie further explained she had taken other science courses including Anatomy, Chemistry, and Physics.

Stephanie described her memories and experiences involving STEM at home as minimal. If Stephanie showed an interest in a STEM related activity, her parents indulged her but did not show an interest in the subject. "[Science] wasn't like a huge emphasis" in her home, she stated, but she did remember some kitchen sink science involving baking soda and vinegar. While Stephanie's parents made sure she had what she needed for school, they were not interested in science. Stephanie felt supported in her interests, but her parents were not science minded and did not implement science in the household. When asked to recall a time when Stephanie had seen her parents engage in scientific inquiry and she simply stated “they don’t do anything in science, they work in business.”

LAB experience. Stephanie recounted she became interested in the LAB during her junior year of high school. Stephanie did not have great experiences with science coursework prior to high school and was not interested in pursuing anything related to science. She wanted to take the necessary coursework for graduation and be done with it. Her interests at that point were geared towards fashion marketing. She felt the sciences were “boring” and “hard.” After several positive experiences in her Honors Biology, Chemistry, and Environmental Science courses throughout her ninth, tenth, and eleventh grade years, Stephanie recognized a budding interest in science. She relayed the courses were very challenging, but she appreciated the real world applicability of the content. Stephanie applied to become a lab aide during her junior year so she could be a part of the LAB during her senior year. Stephanie stated at that point she was not sure what she wanted to do in college. She was no longer interested in pursuing fashion, but might be interested in psychology. Stephanie felt like the LAB would provide her with additional opportunities to work in a science area.

Stephanie recognized she had less experience with the LAB than many of the senior lab aides. She described her duties in the beginning of her involvement with the LAB as “a little intimidating” as she “got a better understanding of the subjects” and learned how to “help kids with labs.” Stephanie stated the kids she worked with during her assigned period were very intelligent and she had to work double time to keep up with them:

> They were really smart kids. They were learning super fast. They were asking [me] . . . crazy questions . . . And that was like a little intimidating for me, because I'd be trying to help kids with labs, and [they would] be writing stuff I don't even know about. It was crazy, but it was a really good experience because you get to go beyond the classroom in science.

Stephanie was inspired to learn more for the course she was lab aiding in and wanted to help more, so she would often research labs prior to their implementation. Stephanie explained her primary duties were “working with the students along with the teacher” during lab activities. She also assisted her mentor teacher with lab set ups and provided a unique student perspective to activities. Once she gained some experience, Stephanie often troubleshot labs and looked for issues with implementation. She shared that, “kids would come to me with their questions. It was a new experience to me, being someone who was qualified I guess . . . When kids would come to me for help with questions that was cool, because it was validating.”

In addition to her hands-on work, Stephanie’s assignments for the LAB included logs detailing her daily activities which she was required to submit to the program coordinator. She also spoke about writing scientific article summaries. She considered them interesting because she was required to find and evaluate primary scientific literature. She stated she was used to paraphrasing articles on news websites, so “it was interesting to go to the actual source and read long lab reports.” She felt these assignments made science “feel more real to [her].”

Stephanie described feeling like she was “closer” to her mentor teacher than a typical student teacher relationship. She said she was assigned to the LAB during a period when her mentor teacher had a class, so they worked side by side during class and lab. Her mentor teacher often shared stories with Stephanie about her own journey with STEM. Stephanie explained:

> Because I got to see a teacher who had been through all the science classes in school, she had had an interesting major . . . and she would talk about her research . . . and you could see that she had a good science experience and how that impacted her life.

Stephanie further elaborated that she loved seeing her mentor teacher get excited about her college major and the research she had done, and "it was very nice to see that people are absolutely interested in [science]."

Stephanie did not know many of the other members of the LAB prior to her senior year. Even still, she recalled fondly "whenever I saw another lab aide, it was sort of like a social community almost. I would know that we had something in common, something to talk about." She explained her interactions with other lab aides never felt "forced" or "awkward" even though they may not have known each other well. She explained these were "comfortable interaction[s]" which she attributed to being a part of the LAB community. According to Stephanie, she reached a "new level of respect" within the science community at FHS because she was part of the LAB. Because of her involvement, the other lab aides and science teachers knew who she was which made her feel more confident.

Impact of LAB. Involvement with the LAB created opportunities for Stephanie to experience STEM from a different perspective. Stephanie stated she began to understand that STEM is more than males in lab coats and articulated an understanding of the role females have in collegiate STEM majors and STEM careers. She gained skills she felt were applicable to the real world and begun to see how science transcended the lab and the classroom. She felt more confident in her personal abilities and felt that participating in the LAB "made [science] seem more applicable to [her]."

Stephanie recognized that gender bias exists in science but felt it unfair. She recounted having a conversation with someone where she mentioned that she might pursue a career in the sciences and was asked "oh, but what about when you have kids?" Stephanie felt the question unfair and "[drove] her absolutely crazy." Being a part of the LAB helped Stephanie see herself in her mentor teacher. The relationship they shared helped Stephanie realize she too could have a place in STEM. "Strong female role models in science" made her see that a career in science is possible and fulfilling.

Above all, participating in the LAB made Stephanie feel "validated." She began to see herself in STEM and STEM in herself. Stephanie began to feel like "I can do this," "I am able to do [science]," and "I am able to be a person in science." The advanced exposure the LAB offered provided Stephanie with the additional time and practice she needed to increase her interest in science and to feel confident in her STEM abilities.

Connections between LAB and life. Prior to high school and participation in the LAB, Stephanie did not enjoy science, nor did she see herself as a scientist. A bit tentatively, Stephanie shared she does consider herself a scientist now but "[she doesn't] know if [she's] allowed to say it yet." She no longer pictures Albert Einstein when envisioning a scientist, but now feels like "anyone can be a scientist." She also feels like science is no longer a specific entity, not "really smart guys sitting down with test tubes for hours." Science is not necessarily like "The Big Bang Theory, which is all [she] thought about in middle school for scientists." Stephanie recognizes science is broad, and she has a place in it. Her research opportunities, experiences, and relationships as a result of the LAB provided Stephanie with the self-confidence she needs to pursue a degree in STEM. Stephanie believed participation in the LAB "[deepened] her connection to science" and taught her that females also have a place in STEM as she was able to apply her own scientific knowledge in new ways and she was able to work with other female lab aides and mentor teachers with whom she could identify.

Participation in the LAB provided Stephanie with a more comprehensive perspective regarding the pursuit of a STEM major in college as well as the reality of life in a STEM career, especially as a female. Prior to participation in the LAB, Stephanie was unsure of herself and the role STEM would play in her life. There was a time when she would never have considered majoring in science in college, but Stephanie believes her LAB experience changed her perspective and forced her to reflect on her choices. Stephanie explained:

> It just forced me to reevaluate, because if you had asked me [about my goals] four years ago, I absolutely would have been like, I'm going to be a fashion designer. It's what I thought I was supposed to do. This is going to sound terrible, but I thought science was nerdy and for boys. Literally, these were my thoughts. And so, I'm glad that I was involved in the science program, especially the LAB aide program because it redefined my thought process.

Suggested LAB improvements. When asked to describe components of the LAB that were least helpful, Stephanie suggested some of the lab work can become redundant, so it would be helpful to work with lots of different people. Stephanie stated there is a

LAB community but would like to see more opportunities for all the lab aides to get to know one another creating an even tighter knit community. She suggested she would have liked to have more opportunities for team bonding of some kind. Stephanie believes this would add an additional layer of support and would foster communication among a wider range of participants.

Data Analysis

Following the verbatim transcription of fifteen 90-minute interview recordings, data analysis began. The transcripts were read and reread many times, horizonalizing or giving equal value to every statement (Moustakas, 1994, p. 118). Careful examination of the interview transcriptions allowed me to identify words, phrases, and thought patterns which allowed me to establish a list of meaning units which were arranged into categories or themes (Moustakas, 1994). These steps ultimately set the stage for composite or overall theme emersion (Smith, Flowers, & Larkin, 2009).

After reading each transcription multiple times paying careful attention to practice epoché or bracketing, I entered into phenomenological reduction by defining units of meaning. This was accomplished by observing patterns in the way female students described their access to and relationship with STEM prior to the LAB experience and after extended involvement with the LAB. Pattern matching was used in this study to compare emerging patterns to those identified as key components of Hackett and Betz's (1981) Social Cognitive Career Theory and Bandura's (1986) Social Cognitive Theory including environmental factors, behavioral factors, and personal factors. I then grouped the meanings into data clusters to support the formation of themes. Ultimately, 14 grouped data clusters developed from this effort which were later collapsed into seven data clusters and then four data clusters leading to the emergence of two themes (see Figure 7).

Participants

Data Clusters

	Ada	Mason	Nina	Stella	Stephanie	Total
Active Learning	17	11	19	8	12	67
Attitudes	13	15	21	11	8	68
Choice Behavior	7	17	26	15	16	81
Community	5	6	6	9	6	32
Influence	25	25	30	24	18	122
Interest	4	4	7	8	10	33
Opportunity	25	19	39	32	21	136
Perception	4	8	4	6	8	30
Real World Application	7	16	21	20	17	81
Relationships	13	9	9	9	7	47
Self-Doubt	4	4	0	0	2	10
Skills Acquisition	30	14	26	18	11	99
STEM Identity	10	9	5	8	10	42
Validation	3	1	1	4	7	16

Figure 7. Clustered Response Frequency. Fourteen data code clusters led to emergence of two core themes as valuable to participants' beliefs about and interest in STEM.

Data Coding

In accordance with Moustakas (1994), the data and evidence for this study arose from the first-person reports of young females who participated in the LAB and described their lived experiences. A calculated effort was made to engage with the data in a meaningful way. Attention was paid to careful and accurate record keeping during the data collection and analysis process, focusing on usefulness of data and context of description (Richards, 2009).

In order to faithfully analyze the data, the *Coding Manual for Qualitative Researchers* was employed which provides detailed descriptions of coding processes employed in qualitative research (Saldaña, 2013). The manual aided me in making a plan for first and second cycle data coding. My first cycle of coding involved attribute coding, structural coding, descriptive coding, emotion coding, value coding, and narrative coding as each method provided a unique lens in which to analyze the data (Saldaña, 2013). Attribute coding organized data across all fifteen interviews and from each of the five participants including responses from the qualifying questionnaire. Structural coding allowed me to take a "grand tour" overview of all the information (Saldaña, 2009, p. 48). Descriptive coding and emotion coding provided me with an opportunity to review the notes I took during each interview and link observed feelings and reactions noted during the interviews to the interview transcripts themselves. Value coding allowed me to combine similarities in value, beliefs, and attitudes about the LAB across all participants, while narrative coding provided me with an agent to understand and analyze the phenomenon of the LAB from the participant perspective in order to capture the essence of the data. Each layer of coding ultimately helped me frame the initial verbiage used for clustering the data.

The first cycle coding process found me immersed in data, with ongoing and continued reflection on the information supplied (Creswell, 2009). According to Richards (2009), qualitative data are looping, not linear which necessitates clustering and re-clustering concepts, visiting and revisiting data as learning occurs. This process of analysis and reanalysis occurred repeatedly, while seeking feedback from others and memoing my thought processes. Informal memoing helped me make sense of the evolution of my codes and clusters and directed my focus on the first cycle coding process setting the tone for the second cycle coding process.

Two second cycle coding methods were employed, pattern coding and focused coding, allowing for further analysis of the LAB phenomenon as perceived by the female participants (Saldaña, 2013). Pattern coding required me to reexamine the initial codes and clusters I used to identify patterns and relationships within the data, permitting further categorization of the data. I then inspected the developing data framework using focused coding allowing me to identify significant and frequent codes while further renegotiating the data clusters into a more succinct representation of the data.

Emerging Themes

Examination of the data across fifteen 90-minute interviews allowed me to identify 864 statements as significant to the study. I continually reviewed the primary groupings of meaning through the perspective of the participant's responses to the research questions, helping me cross reference overall meaning with the developing data clusters. These data were originally organized into 14 coded clusters or data clusters: Active Learning, Attitudes, Choice Behavior, Community, Influence, Interest, Opportunity, Perception, Real World Application, Relationships, Self-Doubt, Skills Acquisition, STEM Identity, and Validation. Response frequency charts were updated in Excel with each fresh cycle of coding and cross referenced with earlier charts and memos as themes emerged.

The coded clusters continued to evolve as data were refined through numerous and varied coding lenses. The initial 14 data clusters were further negotiated into seven data clusters and then into four representing the evolution of meaning. These data included: Active Learning, Attitudes, Influences, Opportunity, Perception, Real World Application, and Skills Acquisition which were further negotiated into Active Learning with Real World Application, Opportunities for Skills Acquisition, Influential Relationships, and Personal Perception. Continued analysis produced two core themes describing the impact of participation in the LAB on participants' beliefs and interest in STEM. The last process in phenomenological investigation is the synthesis of meanings and essences into "a unified statement of the essences of the experiences of the phenomenon as a whole" (Moustakas, 1994, p. 100). The two themes that evolved through the data relating to how female students perceive the impact of participation in the LAB are *active learning with real world applications and opportunities for skills acquisition* and *influential relationships altering personal perception* (see Figure 8).

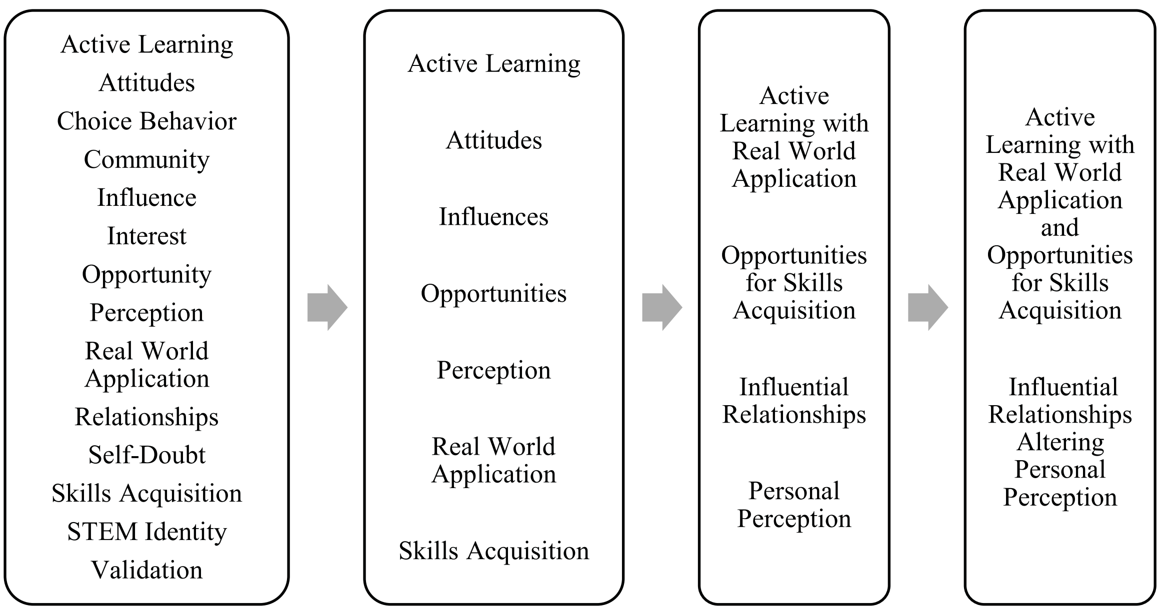

Figure 8. Evolution of Data Clusters. Evolution of coded clusters through multiple coding lenses allowing for the emergence of two core themes.

Overview of Theme One

The first theme *active learning with real world applications and opportunities for skills acquisition* encompasses the significance LAB participants place on experiences which allow for application of knowledge, practice, and real world application of content.

These opportunities for extended practice and application are seen as valuable components of the LAB increasing participants interest in STEM. Offering access to curriculum which requires critical thinking, writing, and research beyond the traditional classroom is important. The essence of this theme relates to how the participants value hands-on STEM experiences which they see as directly beneficial to their learning and describes how participants understand the usefulness of the LAB to their growth as a student of STEM. Participants suggested opportunities to work together and assist others as impactful components of the LAB increasing interest in STEM.

Overview of Theme Two

The second theme *influential relationships altering perceptions and science attitudes* describes the impact that students' participation in the LAB had on their perceptions and science attitudes as a product of their interactions with mentor teachers, other lab aides, and the LAB community. Participants valued their relationships with the other female teachers and students involved with the LAB and described role modeling and social norms. Positive interactions with mentor teachers inspired the participants altering the way they identify with STEM. Participants credit the LAB with increasing their access to science and altering their perceptions of females in science. The essence of this theme is developed in the influence females in STEM can have on one another and is characterized by changes in participants' attitudes and expectations about STEM. Positive interactions in the LAB altered participant reports about their beliefs and interest in STEM.

The subsequent discussion is designed to illuminate and substantiate the findings of this study. Further quotes from interview transcriptions are offered to highlight the voice of the LAB participants in order to best represent their lived experience.

Theme One: Active Learning with Real World Application and Opportunities for Skills Acquisition

Active Learning. All the participants described significance associated with active learning experiences and real world application of scientific information. By real world application, participants meant they practiced and applied scientific skills such as setting up labs and researching scientific topics. They appreciated the hands-on nature of the LAB and their ability to interact with science daily. Participants shared stories of learning opportunities in the LAB and compared them to times in their educational careers when science was taught through a hands-off approach. Each participant recalled incidences working in the LAB where they were able to apply their knowledge of science in new ways, often to help others during lab experiences. Ada described leading a scavenger hunt outside with another lab aide for a special education science class. She also spoke about "[looking] at different plants and different pigments of plants" and feeling like "that sort of thing was really cool" because she loves the outdoor aspect of life sciences. She also recounted searching for representative specimens for lab activities at the request of her mentor teacher. Mason remembered assisting her mentor teacher with demonstrating CPR, the Heimlich, and the proper way to put on personal protective equipment for a class of Healthcare students. She also talked about "[walking the students] through the process of lab draws" on prosthetic arms and "showing them what [she] had learned." Nina spoke about her work in an Honors Biology and AP Biology course where she migrated through the labs "[assisting] with the class itself" by checking student progress and answering questions when they arose. Similarly, Stella and Stephanie both described helping out during labs by making sure other students knew how to use equipment properly and problem solving as issues arose in the labs. Stella laughingly spoke of "cleaning test tubes and cleaning the tables" as a necessary evil to conducting lab work, while Stephanie stated because of her LAB experiences "[she] got a better experience than you would just sitting in a classroom taking notes." All participants asserted the opportunity to engage in hands-on science activities contributed to their positive experience in the LAB and helped to see the application of science beyond the traditional classroom.

Access

According to Stephanie "a lot of time in the classroom, you get a good grade . . . but it doesn't show you anything." She goes on to say "actually experiencing [science] more" allows students to commit information to memory. Experiences stay with you far beyond memorizing and getting good grades and "the [LAB] experience stays with you" (Stephanie). Stephanie explained "research made [science] feel real" and Ada described finding primary literature and "[doing] a lot of research without just reading the summaries, which was really cool." Nina spoke of "really interesting assignments [she] would not have had a chance to do if [she] weren't a lab assistant" which included researching scientific topics that interested her. Mason recounted hating Chemistry when she was in the course, but her work as a lab aide required she apply what she learned in Chemistry. She joked "[she] saw like how it's actually used and now [she doesn't] hate chemistry as much." Stella reported opportunities to research areas that interested her which she thought was “so cool and interesting” because it made the information more interesting and “opened up possibilities about other types of experiences.”

Each participant detailed experiences of setting up labs and conducting scientific experimentation, as well as prepping lab materials. Ada spoke of “running [diagnostic] labs” for sample data and Mason recounted helping her mentor teacher trouble shoot new labs by “[talking] over labs . . . and talking about expectations and what could go wrong.” Stella and Stephanie detailed lab setups, while Nina discussed helping her mentor teacher research new lab activities. While each participant engaged daily in slightly different LAB activities based on need and content area placement, each considered their participation in these activities instrumental in their connections to STEM.

Real World Application

The participants also considered their involvement in real world science activities through the LAB a strong contributing factor to their interest in STEM. Ada mentioned she had no interest in STEM prior to high school and her LAB experiences supported her growth in STEM as they provided her opportunities to apply her knowledge. Mason recounted a funny story where she had an opportunity to apply her knowledge of pressure to a lab setting stating “if you put a bone in soda to show how it dissolves, you can’t put the lid on it because the pressure gets too high . . . when [she] walked [into her lab] the next morning there was a chicken wing across the floor” and she got to explain pressure changes. Nina felt her work in the LAB is “like a real professional would do in the real world” and she sees the applicability to her growth in STEM. Stella explained how the LAB prepared her for college because “it’s such a unique program” offering her chances to apply her knowledge and analyze data, while Stephanie described opportunities to “do science, beyond just being a student." While all participants took part in different LAB activities and made meaning of them in their own way, each related their experiences to the real world and felt a deeper connection to science as a result.

Skills Acquisition

The participants considered opportunities for skills acquisition to be important characteristics of the program. They asserted the LAB provided them with access to opportunities and material they would not have learned in a traditional science classroom and describe the skills they developed as transferable and interconnected. Lab setup, technical writing, and research ranked high among skills considered useful to their growth in STEM. Nina described "one of the perks [of being in the LAB was getting] a lot more experience" and "a lot more exposure" than other kids who are in high school, while Ada felt "working for someone else and with other people" gave her valuable skills. Stella spoke of having the opportunity to "dive further into [her] favorite area" and Mason explained her experiences gave her "that second understanding of not only how you do something, but why you do it, what the goal is." Stephanie offered her experiences in the LAB made science "feel more real to [her]."

Learning how to read a protocol and set up labs was mentioned by each participant multiple times. Feeling confident reading a protocol and preparing the materials necessary to conduct lab work was also deemed useful. Stella recounted prep work she did in Anatomy and Biology labs where she felt she got "double the experience" because she was responsible for organ preparation and dissection when she worked in the Anatomy class, and many different tasks including statistical data analysis when she worked in the Biology class. She explained she was responsible for "setting up a lab of some sort" at least once or twice a week. Nina talked about "handling lab equipment" and familiarizing herself with their "proper names and proper uses" for Honors Biology and AP Biology labs and described "getting that extra time during school hours to be a part of a science classroom setting" as beneficial to her learning. Both Stephanie and Ada considered setting ups labs as interesting. Stephanie appreciated the chance to "see like science, how it works" and Ada felt her extended time in a lab setting gave her the ability to "do what [she needed] to do, instead of waiting for someone to tell [her] what has to be done" which she felt was a useful skill in science. Mason felt her experiences might have been different than other lab aides who were working in core science courses because her experiences were outside those of a traditional science class. She explained she was not "necessarily pouring into beakers, but [was] learning how to draw blood from an arm and how to put people in a backboard" which she saw as more relatable to her STEM interests.

Research and technical writing were offered as beneficial components of the LAB and seen as an opportunity outside what is offered in a traditional science classroom setting. Each participant recounted having chances for independent research in an area of interest. Participants felt the summaries and critiques of peer reviewed scientific articles, which were required of them as a part of their assessment in the LAB, increased their interest in science as each had a choice in the research she explored. Ada stated research was "hard for [her], but [she] felt smart doing it" and explained the process of finding scientific articles allowed her the opportunity to "[find] a lot of articles on a bunch of different things" increasing her knowledge overall which she found "really cool." She asserted "writing a summary and critique of a scientific experiment [and] other scientific research" increased her confidence in her scientific abilities. Mason spoke of having her own research opportunities and time "to develop [her] own thoughts." Nina described her exposure to research and technical writing as "huge" explaining she would not have had the opportunity in high school outside of the LAB. She went on to say that research exposed her to "really big science words that [she] wouldn't have even understand before" and "having that exposure [would] really help [her] in [her] academic field in the future." Stella opined having the opportunity to find, read, annotate, and critique scientific articles contributed to her learning and aided her abilities to "interpret . . . data" providing "a unique way of connecting students to the subject." Stephanie described finally having an opportunity to "find an actual real scientific article" and review it. According to Stephanie, this experience "[gave her] a lot of other resources to find more articles" which she found "really interesting." Prior to her research in the LAB, Stephanie recounted she would always "wind up reading paraphrased articles on news website, so it was interesting to go to the actual sources and read the long lab reports" and stated her involvement in the LAB "showed [her] more research."

The participants also expressed the transferability of skills they acquired through their participation in the LAB. Ada stated "outside of being a science kid and being able to learn a lot about science, [she felt] like it's set [her] up for life with any job that [she has] even if it's a job where [she's] temporarily not in science." Ada further commented the LAB "set [her] up" to be able to work in a future job "with the skills [she] learned working for someone else and with other people." Mason believed the LAB "opened her eyes" to the interdisciplinary nature of science. She realized the skills she learned in Biology, Chemistry, and Physics, could all be used in her field of interest. According to

Mason, when she "[saw] all these different fields coming together, it gave [her] a better understanding of how healthcare is, where all the sciences come and have a massive baby" which is "really fun." Stephanie learned many transferrable skills through her participation in the LAB which she described as "interesting." She talked about setting up labs, writing reports, researching scientific topics, and helping her mentor teacher create assessments, as well as collaborating with other faculty and her peers and asserted these skills would help her in college. Nina described her experiences with the LAB as "unique," and explained the skills she acquired could later be used "in plenty of other settings" including her collegiate career as she considered herself "ahead of the game." She remarked these skills were useful when "[she was] doing labs in another [class]" and when she was working with her peers she could help answer their questions. Nina thought because of the additional "practice" she has had "an easier time [adjusting] to a college lab setting" than typical high school students. Stella related the transferable skills she learned to her interest in teaching and thought "the LAB was more of a glimpse into how teaching and science intermingle." According to Stella, "being around [the LAB] for so long" allowed her to "learn . . . more about how they're related." The participants described their experiences with the LAB in a different way, but each believed the skills they learned by participating in the program made them better students.

Theme Two: Influential Relationships Altering Perception and Science Attitudes

Mentor and Role Model Influences.

All participants recalled fondly their interactions with their female mentor teachers who acted as role models and made STEM seem accessible. These positive interactions with female mentor teachers encouraged participants enhancing their beliefs and interest in STEM. Participants described the influence they experienced through interactions with other lab aides and the LAB community, enjoying being a part of something they saw as meaningful. The participants appreciated the relationships they formed by being a part of the program and described role modeling and social norms beyond those associated with their mentor teachers. Being a part of the LAB made them feel special. Participants credited the LAB with increasing their opportunities and skills, but also altering their perceptions of females in STEM. The relationships they formed went beyond the classroom and impacted how they saw themselves and females in STEM. Changes in science attitudes were discussed across all participants who relayed an increase in self-confidence.

Each participant spoke extensively about the role of their mentor teacher in their LAB experience. Mentor teachers were seen as role models who made STEM more attainable and desirable. The close relationships the participants shared with their mentor teachers impacted their beliefs about STEM. Ada described feelings respect for her mentor teacher. She talked about their relationship being “mutualistic” and “positive” explaining she believed her mentor teacher was like a “second mom.” The “great relationship” they shared made Ada realize STEM was possible. Ada credited her mentor teacher with her overall interest in STEM saying she “would not have gone into science without her . . . [she] impacted [her] for life.” Ada explained her mentor teacher was there for her personally influencing her “motivation to get things done.” Additionally, Ada responded to the passion she saw her mentor teacher exude explaining that for her, “what made the biggest difference in wanting to be in the science field was having the teacher be passionate about it.” Prior to participation in the LAB, Ada had not spent much time with females who worked in STEM fields and she posited her relationship with her mentor teacher opened her eyes to a greater realm of possibilities within the sciences.

Mason described the relationship between her mentor teacher as “very close.” She credited her mentor teacher with not only helping her find an internship, but also with supporting deeper relationships with other students as Mason explained there were times when she “struggled . . . to fit [in].” Mason’s mentor teacher was a “big guiding factor in [her] life” who helped her form “relationships she would not have had otherwise” and who aided her during “college applications.” Mason explained she was thankful to have someone who was there to “guide [her]” which she felt was “incredible.” Having someone “who can show you the path you need to take, kind of educate you more on what options are in that field” is hugely important. Mason clarified her mentor “definitely taught [her] what she wants to go into, but also just kind of taught [her] how to be a person.”

Nina also described having a “really close relationship” with her mentor teacher. She believed the “one on one relationship with the teacher the entire year” allowed her to form “a really close bond . . . you understand each other more than just a regular student would.” Nina described feeling as if she could ask her mentor teacher for help with anything because she was a professional in the field. Nina commented her mentor teacher was a “really good networking opportunity’ too because she knew she would always be able to contact her for guidance and assistance even when she was in college. She explained the relationships lab aides form with their mentor teachers are “really special” because “they’re really there for you whenever you need them.” Nina went on to say “having a female role model really helped me pursue what I wanted . . . because I see myself in that role" and "they're so happy to share everything they've learned and everything they've done." She spoke of having a "VIP pass" to the science department which inspired her. Nina recalled thinking "having someone to look up to has really helped [her]."

Stella ascertained she got a "behind the scenes" experience by participating in the LAB. She spoke of observing how her mentor teacher balanced her professional and personal life. Stella remembered thinking her mentor teacher was "so awesome" because she had an "I got this" attitude. Stella recounted feeling as if she learned not only organizational skills but had also received life advice from her mentor teacher whom she respected and admired. She opined her role in the LAB brought her closer to other female science teachers as well who acted as role models for her. Stella described the "importance of female role model[s] in science" who have offered her help and guidance. She explained forming relationships "just make [her] feel so much better about going and pursuing a subject like this." Stella stated the females in the program had her back and it was "comforting to know those women went through the same thing" and could provide guidance and advice. Having someone "look out for you" and "be there for you" is vital. Stella described the passion she saw in one of the female LAB instructors explaining she too wanted to invoke that same kind of passion in her own students one day explaining the "relationships I've been able to establish . . . have inspired and shown me how I can achieve that."

Stephanie described feeling close to her mentor teacher and enjoyed her perspective on science. Stephanie interacted with science more through her mentor teacher who spoke to her about her own personal research. Stephanie recounted thinking it was nice to see someone who "had a good science experience" and how that impacted her life. Through the LAB, Stephanie believed she had "strong female role models in science" which was helpful and made science seem more accessible. She thought there were often stigmas associated with females in STEM and it was good to have female role models who had lab experience and could talk to their students about it. "Getting that close relationship with teachers" and being able to "see that they get so excited when you would ask them about their major and what research they've done" made Stephanie realize STEM careers made her mentor teachers happy. She asserted "it was nice to see that people are absolutely interested in [science]."

Relationships and Community

All participants explained the LAB created an experience where they were a part of a community in which the social norms aligned with their interests and fostered acceptance by their peers. Each participant described the social place the LAB held in her daily life and within the context of FHS. According to Nina, lab aides at the high school were "kind of set apart and [they] have [their] own LAB society." Ada noted this LAB society was "recognized by the principal" and that it "just shows that it's a big focus in [their] school, that [the LAB is] really important in [their] school." Stella was "honored" to be a part of the LAB and noted "it [was] such a distinct and unique community to be a part of." Participants found common ground through the shared social norms facilitated by the LAB and believed they were part of a "comfortable . . . social community" where they "would always have something to talk about and it didn't feel awkward or forced," according to Stephanie. Nina recounted high school being "a really hard time for students" and asserted the LAB provided a program for "people like [her]" who shared her interest in science. Ada deeply valued this community of peers who shared her interest in science as she “[had] other friends from the LAB who are going into STEM fields” but “outside of the LAB [she didn’t] have a ton of friends” who were planning to pursue STEM. Stella noted her best friend was also a lab assistant who “had been an official lab aide longer than [her].” Stella valued the comradery and perspective of her new friend in the LAB community describing their relationship as “nice and refreshing” because “[the senior lab aide] had some new insights into systems . . . [and] the tips and tricks of lab aiding.” Mason also valued the relationships she made through the LAB community as some lab assistants she had known “since elementary school” became her “really good friends” through their joint participation in the LAB. Nina described this sense of lifelong friendship and community that she felt within the LAB community when she spoke about the “connections” she made with both past and present lab assistants. She expressed she would “know those classmates forever and [she could] always reach out to them [and] reach out to people who have already matriculated into college and they [could] help [her].” The LAB remains a “community of science kids in the school” according to Ada, where those interested in science share common interests and a love of science is considered a social norm.

Attitudes

In addition to providing participants with positive STEM role models and a community of peers who share common STEM interests, the participants asserted the LAB elicited feelings of validation and affirmation which ultimately lead them to be respected members of the LAB community. Stella explained that “the LAB definitely affirmed [her] love of science” as “being around [the LAB] for so long and getting to learn . . . more about how [science and teaching] are related and how to succeed in that realm just kind of made [her] love [science] even more." According to Stella, "when [she] actually had the opportunity to be involved in a program like [the LAB], [she] was like yes, this is definitely what [she] wants to do." Stephanie expressed a similar feeling of affirmation when she stated the LAB made her believe "[she] knew what [she] was doing and that [she] was doing the right thing." Nina described her experience "working with biology a lot" through the LAB made her "more comfortable in the area," which affirmed her conviction that biology is something that she will "probably pursue in the future." Ada recalled an experience where she helped some freshmen conduct a difficult gel electrophoresis lab experiment beaming, "it was so cool to see them be amazed that I could do it so easily."

Experiences like the ones described above, affirmed participants' feelings about STEM and their place in it. Ada added she, "[loved] the fact that being in the science field meant that [she could] make a difference to someone." Ada indicated she "felt like a real scientist in the LAB . . . [she felt] like [she mattered] to the people [she worked] with in the program" and that "the program to [her] was making [her] feel like [she] was making a difference to someone else." Mason remembered many "guest speakers" who were brought to speak to the healthcare lab aides and noted "it [was] always a woman who [came] in." She explained seeing these female professionals in her field of interest allowed her to realize that choosing a career in healthcare "actually [was] an option." According to the group of participants, a feeling of respect and purpose facilitated by the LAB contributed to feelings of validation of their interests in STEM.

Ada articulated her feeling of validation in terms of her work with her mentor teacher and other students. According to Ada, "when you're a part of the LAB, you mean something and you have a purpose to . . . the teacher that you're with" and her mentor teachers and others involved in the LAB "[viewed] her with respect." Stephanie also believed she had "reached a new level of respect" among her peers and community working as a lab aide. She recounted a "new experience" as "someone who was qualified" where "students would come to [her] for help." Mason indicated feelings of validation in her newfound ability to help others with concepts she had mastered through the LAB. According to Mason to be able to "go back and teach somebody, it kind of gave [her] that 'yes, you actually have learned something'" feeling. Beyond her experiences helping other students, Mason asserted her participation in the LAB, "opened [her] eyes and also showed [her] how many people are excited to do science." Her exposure to multiple professionals in different disciplines in her area of interest helped Mason validate her own interest and desire to pursue STEM. Stella also expressed a variety of LAB experiences which contributed to her comfort with her explicit interest in STEM. Stella felt her completion of article critiques and summaries allowed her to "personally focus on her own level of learning" which validated her interest and desire to "explore that subject even more." She asserted "the [LAB] has such a unique way of connecting students to the subject." She also spoke of the way the opportunity to call herself a lab aide made her feel. Stella enjoyed inclusion in the rank of students who participated in the LAB stating "I love that feeling of saying you're a lab aide." Nina expressed similar sentiments as she spoke about peers who had also participated in the LAB before attending college in a STEM program. She remarked, "the [LAB] helped them to pursue that area and . . . [the LAB] added fuel to whatever they wanted to do." Nina believed her connection to her predecessors and the success she saw validated her own ambitions to enter a STEM field. While each participant identified unique experiences, which affirmed and validated their STEM interests and aspirations, they collectively experienced acceptance and legitimacy in the LAB.

Perceptions

Each participant experienced changes in her perception of a scientist, her potential role in science in general, and her perceived ability in STEM. When asked about her perception of a scientist before her participation in the LAB, Ada envisioned an "old White man with white frizzy hair." Now Ada named another female lab aide when asked to describe a scientist. Similarly, Mason's original description of a scientist included a "very tall White man," yet after her participation in the LAB, she asserted she no longer had a particular picture of a scientist in her head. She realized anyone could be a scientist and science encompassed so much more than she originally thought. Her participation in the LAB "took away the perception that [she] had and instead of putting a different one in place, it kind of opened [her] eyes to how much science is." Nina believed a scientist is "still a person, but maybe not with funky hair" in contrast to her previous description of "Einstein . . . mixing chemicals together and watching them fizz up." She now realizes science is a formalized process and often a collaborative experience. Stella ceased to envision a "man with a lab coat and crazy hair" and began to see science is everywhere and for everyone. Stephanie explained "anyone [could] be a scientist" and no longer pictured "Albert Einstein." While the participants experienced a change in what and who they perceived as scientists, this change extended to their personal perceptions as the participants began to identify as scientists and hold a role within the context of STEM.

When asked if they considered themselves a scientist, all of the participants conveyed they regularly engage in science. While Ada, Nina, and Stella confidently affirmed they are scientists, Stephanie stated she "[wants] to say yes [she is]" and Mason decided she is "working towards" becoming a scientist as she continues to participate in STEM. The participants went on to express how exposure to females in STEM through the LAB influenced their changes in how they perceived females in STEM and how they perceived their personal roles in the realm of STEM. Ada realized there are females in all areas of STEM, even the math based sciences. Likewise, Mason felt exposure to her female mentor teacher and female professionals helped her see how many females work in scientific fields. According to Mason, "[she] never realized how many women actually are involved in science." Nina recognized the rarity of her exposure to a STEM program that included so many females who acted as role models and demonstrated the reality of choosing a career in STEM from a female perspective. Nina said she was "thankful [to be in a place] where girls dominate the science field" as she remembered saying 'he' a lot growing up when referring to scientists. It "boosted [her] morale" to see so many women in STEM. She also believed this exposure to female scientists was important as it created confidence in the subject area. She enjoyed interacting with the female LAB instructors conveying, "they [were] super relatable and super fun to talk to . . . you almost feel like you're one of them when you're sitting down talking to them." Stella also focused on the relatability of the females in the LAB and felt when she related to her teachers on a personal level, she was inspired and wanted to emulate their practices and pursue STEM.

She remarked the LAB made a consorted effort to involve girls in STEM. She expressed "whenever [she] saw lab aides [she felt] like they were always girls . . . obviously [she] knew guy lab assistants, but [she] most prominently remembered the girls in the program." Stephanie's exposure to females in STEM via her participation in the LAB allowed her to "see that it is possible" to succeed in the field as a female. Being a part of the LAB showed her that while a gender gap in STEM exists, it does not have to remain this way. The collective experience of all participants indicates that the LAB provided participants with a STEM experience that changed preconceived ideas regarding gender roles in the field.

Participation in the LAB impacted the attitudes participants held regarding STEM. Ada explained prior to high school and participation in the LAB she had no interest in science. In fact, she aspired to teach English. Ada now reported, "[she felt] pretty confident in [her] science abilities" and now has interest in becoming a veterinarian, but could also still see herself teaching science. Mason reported no extracurricular interest in science prior to the tenth grade. Her experiences in the LAB led her to become increasingly interested in pursuing a career in STEM and, according to Mason, "[the LAB] showed [her] . . . I don't just like healthcare, I love it" and "it's a thing [she] really [does] want to pursue." While Mason felt her choice of college majors will be difficult, she feels confident in her abilities. Nina asserted that while she had an interest in STEM upon entering the LAB, she attributed her choice of STEM major to her participation in the LAB as it gave her the confidence to pursue such a competitive career as neuroscience. According to Nina, "the LAB kind of helped build [her] confidence" and made her feel capable of doing "such a hard major." Conversely, Stephanie expressed no interest and a negative attitude towards science upon entering high school. She planned to pursue a career in fashion marketing and considered STEM career fields for boys. She said she went into high school "science dumb" and maintained "there was a time [she] would [have] never consider[ed] science as a major." After her participation in the LAB, she knew "[she could] do this" and "[she] is able to be a person in science." Stephanie now believes there is a place for her in the STEM field and reported majoring in Biology in college with aspirations of going to medical school. Stella felt the LAB helped her explore possible careers in science as "science is literally involved in everything." With plans to pursue a career in teaching secondary STEM, Stella viewed the LAB as an internship opportunity where she would have a chance to see if a career in STEM was an appropriate fit for her.

Summary of Findings

Using Seidman's (2006) three-interview series, the participants in this study established their involvement with the LAB and its impact on their lives. While each participant had varying positive interactions with STEM prior to high school and involvement with the LAB, common themes emerged across all participants as aspects of the LAB which are impactful to participants' interests and beliefs about STEM. Through the lens of Bandura's (1986) Social Cognitive Theory, the core themes collected from the analysis of interview transcripts from five female participants' experiences with the LAB, align with the model of reciprocal determinism suggesting environmental factors, behavior factors, and personal factors contributed to each participant's overall experience with the LAB.

Behavioral factors such as opportunities for real world practice and additional occasions to acquire skills ranked high among benefits of the LAB, increasing their interest and beliefs about STEM. Participants spoke of the social norms of the LAB where there were other females in STEM whom which they could identify. Environmental factors such as the LAB community and female mentor teachers who acted as role models had a positive influence on the participants' interest and beliefs about STEM. Participants spoke of their increased self-confidence and perceptions of females in STEM. Personal factors like science attitudes changed during and through the LAB. Consistent with Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory, the triadic reciprocality of environmental, behavioral, and personal factors associated with participation in the LAB influenced interest and beliefs about STEM (see Figure 9).

Statements of Significance by Percentage			
Theme		Percentage of Data Relevant to Theme	
Theme 1: Active Learning with Real World Applications and Opportunities for Skills Acquisition			
B	Active Learning	9	49
B	Real World Application	10	
E	Access	17	
B	Skills Acquisition	13	
Theme 2: Influential Relationships Altering Perception and Science Attitudes			
E	Mentor/Role Model Influences	16	51
E	Relationships/Community	10	
P	Attitudes	14	
P	Perceptions	11	

*Behavioral factor (B), Environmental factor (E), and Personal factor (P).

Figure 9. Demonstration of core themes as it pertains to participants' beliefs and interest in STEM.

Conclusions

Consistent with Moustakas' (1994) modification of the Stevick-Colaizzi-Keen Method of Analysis of Phenomenological Data, this chapter provides biographical information for each participant along with their history with STEM. What they did in the LAB, what they gained from the experiences and what it means to them are offered as evidence for the connections the participants make between their participation in the LAB and their lives. Some themes were exclusive by participant, but overall themes emerged as important to participants' perceptions of the role of LAB in their beliefs and interest in STEM. The two themes that evolved through the data relating to how participants the perceive the impact of participating in the LAB on their beliefs and interest in STEM are active learning with real world applications and opportunities for skills acquisition and influential relationships altering perception and science attitudes.

Chapter V

CONCLUSIONS

Everybody is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid. ~Anonymous

Introduction

The purpose of this study was to explore the lived experiences of female students who participated in a Student Lab Assistant Research Program (LAB) for a minimum of 2 semesters in high school. The goal of this phenomenological study was to explore the perceptions of the participants about the impact of participating in the LAB on their beliefs and interest in STEM and the study aimed to elicit information about aspects of the program seen as most and least beneficial, as well as suggestions for improvements Secondarily, findings from the study could add to the existing literature of pre-collegiate STEM opportunities. In an effort to learn more about the LAB and increase understanding of this pre-collegiate STEM program, five former lab aides were interviewed, and their stories were told. The analysis of participant interviews resulted in two core themes revolving around *active learning with real world applications and opportunities for skills acquisition* and *influential relationships altering perception and science attitudes*. This chapter presents a discussion of the findings including connections to existing literature on impactful STEM programs, significance of the findings, limitations of the dataset, and recommendations for future research. I hope the voices from the participants will relay what is needed within high school science programs to supplement traditional science coursework.

Summary of Findings

There has been much data discussing the ‘leaky pipeline’ in STEM and it has been argued the plumbing itself is broken (Samarasinghe, 2017). Research shows that extended exposure to pre-collegiate STEM opportunities has a positive impact on female students (Maltese & Tai, 2011; Provasnik & Planty, 2008). Additionally, pre-collegiate STEM programs that focus on individualized learning and relationships are shown to have a positive contribution to STEM matriculation for female students (NRC, 2011; Nugent et al., 2010). Lack of meaningful exposure (Edzie, Alahmad, & Alahmad, 2015) and lack of female role models (AAUW, 2010) are significant predictors of female attrition in STEM. If female high school students are not afforded opportunities for positive STEM exposure during high school, there may negative ramifications for STEM degree program choice (Sadler et al., 2012). The responses and the interview questions (Appendix A) revealed much about participation in the LAB from the perspective of the participant with regard to interests and beliefs in STEM.

The research questions that guided the study are listed below with answers derived from participant interviews. Direct quotes and composite meanings are offered in Chapter 4 substantiating the information below.

1. What are the perceptions of female lab aides about the impact of participating in LAB on their beliefs and interests in STEM?

   Components of the LAB influencing beliefs and interests in STEM resulted from extensive access to science within the school day offering opportunities for active learning and real world application of scientific concepts, as well as chances for scientific skills acquisition. Mentor and role modeling relationships along with a community of science learners also influenced participants' beliefs and interests in STEM. The aforementioned variables resulted in changes in reported interest in science as well as changes in science attitudes with reports of increasing self-confidence in science abilities and reduced feelings of self-doubt.

2. What do female lab aides perceive as LAB elements most beneficial to their beliefs and interests in STEM? What elements are the least helpful?

   Participants reported the most beneficial components of the LAB as:

   - Choice in learning/research.
   - Communication skills.
   - Experience with science outside the traditional classroom setting.
   - Extended access/exposure to content.
   - LAB community.
   - Mentor teacher relationships.
   - Real world application experiences.
   - Research skills.
   - Technical writing skills.

   Participants reported having opportunities to learn something new each day and reported little with regards to components of the LAB which are least helpful. Nina and Stephanie both articulated it was important to consider student compatibility with particular mentor teachers as well as student interest in particular scientific disciplines when assigning student participants in the LAB to a mentor teacher. They believed this measure could contribute to facilitating a positive LAB experience for every participant as some labs require more hands-on wet lab work, and others are more oriented to conceptual and theoretical lab activities. Nina explicitly suggested a dedicated matching system for participant and mentor to ensure their interests align. Stephanie suggested to have students be assigned to multiple mentor teachers during their participation in the LAB and rotate through different labs to provide a more diverse and comprehensive experience.

2A. What do female lab aides suggest to improve the LAB and, perhaps, to increase the number of female students interested in collegiate STEM majors?

When asked for suggestions for improvements to the LAB, all participants felt the program should include more student participants so more individuals could benefit from the experience. Participants also provided suggestions to better the LAB experience and increase the number of female students who might be interested in collegiate STEM:

- Adding more technical writing opportunities would provide additional pre-collegiate exposure to primary scientific literature increasing opportunities for data analysis and critiques.
- Getting more mentor teachers involved to increase overall involvement in the LAB as program involvement is limited by the availability of mentor teachers.

- Hosting LAB community socials and team building opportunities to increase interactions among lab aides who might not otherwise have a chance to interact.
- Educating surrounding schools about the LAB and the benefits of a pre-collegiate STEM program which positively impacts reported beliefs and interests in STEM amongst participants.
- Matching like-minded participants and mentors as a means to ensure all those involved in the LAB have an equally positive experience.
- Scheduling multiple lab aides during the same class period allowing for greater interaction between participants which fosters a scientific community amongst the lab aides.
- Assigning multiple lab aides to work under the same mentor teacher increases the number of possible participants in the program as well as offering lab aides a chance to collaborate.

Connections to the Literature

The interconnection of environmental, personal, and behavioral factors plays a role in STEM interest and choice. In the context of this study, Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994, 2000) provides a framework for understanding the impact of participation in the LAB on female students' interest and beliefs in STEM and thus their STEM choices. Environmental factors such as access and exposure to STEM, female role models and mentoring, and the LAB community and relationships with other lab aides are all identified as valuable to program participants. Personal variables such as perception of females in STEM that dissuade gender stereotypes and extended access to STEM which increases self-confidence are also recognized as valuable components of the LAB experience. Active learning, real world application, and the acquisition of skills recognized as useful and transferable are acknowledged as impactful components of the LAB. The interconnection of environmental, personal, and behavioral factors afforded through participation in the LAB had an impact on program participants' beliefs and interest in STEM. After analyzing the data from all interview transcripts, 25% of the statements of significance aligned with personal factors described per the SCCT (Lent, Brown, & Hackett, 1994, 2000). Behavioral factors and environmental factors comprised 32% and 43% respectively (see Figure 10). The triadic reciprocality of behavioral, environmental, and personal factors impacted the self-efficacy of the LAB participants and influenced their choices regarding collegiate STEM degree programs.

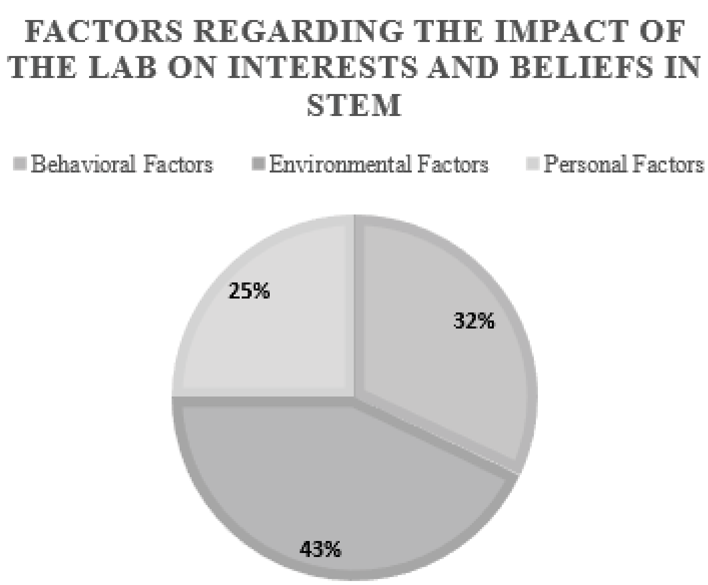

Figure 10. Environmental, behavioral, and personal factors which impact perceptions regarding beliefs and interests in STEM by percentage through the lens of Bandura's (1986) Social Cognitive Theory.

Choice to major in a STEM degree program in college was articulated by all study participants with credit given to the LAB in varying degrees. While it is impossible to say participation in the program is the only determining factor towards STEM degree choices by participants, data from the study indicates participation in the LAB had a positive impact on their choices.

Theme One: *Active learning with real world applications and opportunities for skills acquisition* speaks to the extent exposure to science participants had as result of the LAB, as well as the skills they acquired through participation. Previous research has demonstrated a need to offer active learning experiences which mirror the real world as a means to plug the leaky pipeline (Graham et al., 2013; Johnson & Johnson, 2016). Traditional science coursework often does not offer students sufficient opportunities to apply the scientific method, think critically, or work independently on their own research (SCHELP, 2015). Study participants suggested the LAB offered them extended exposure to core content, lab setup, research, and application of their knowledge. Gallant (2010) describes a need to offer nontraditional coursework promoting student choice and individualized learning. Additionally, the LAB participants reported being appropriately challenged in a supportive environment which promoted authentic science experiences and individualized learning. Participants similarly shared stories of choice in research and learning technical writing skills which they perceived as useful and planned to use in future endeavors.

Active learning is a known contributor to female persistence in STEM (Graham et al., 2013) and is described as opportunities to do and think as opposed to just watching, listening, and taking notes (Felder & Brent, 2009). Participants in this study described helping other students during labs, learning to do research and set up labs, hunting for representative specimens, running diagnostic labs, demoing procedures, and familiarizing themselves with science equipment. They also described times when they conducted their own preliminary research by creating a literature review and learned to analyze and critique scientific articles. Participants reported these activities improved their working vocabularies and their technical writing skills.

Extended pre-collegiate STEM exposure greatly influences female enrollment in college and persistence in STEM programs (Edzie, Alahmad, & Alahmad, 2015). Traditionally pre-collegiate STEM exposure outside of core coursework occurs before or after school, on the weekends, or during the summer (Kim, Cross, & Cross, 2017; Sahin, Ayar, & Adiguzel, 2014; Sahin, Ekmekci, & Waxman, 2017). Often these experiences are short-lived and expensive, excluding those who cannot afford the fees or provide the transportation (Mostafavi, 2016; Wong, 2015). Considering the LAB is an academic course offered within the school day, participants have extended access to science content within the school day, meeting approximately 250 minutes per school week at no cost to them or their families. Participants described making a place in their school schedule for the LAB because they recognized the benefit additional access to STEM would offer them in their future endeavors. Collectively, these factors solidify the value of the LAB as a supplementary in school pre-collegiate STEM opportunity.

STEM programs which take into account both science coursework, oral/written communication, and cooperative communication are particularly attractive to female students (Capraro et al., 2017). The LAB addresses these factors in a variety of ways. For example, participants communicated that the LAB provided chances for research and technical writing, as well as opportunities to problem solve and collaborate. Lab aides often aided their mentor teachers during lab work fostering strong oral communication, teamwork, and leadership. Communication among lab aides was encouraged and program participants often worked together on assignments and set up labs, run lab demos and diagnostics, and find lab supplies and specimen. These findings suggest a need to offer programs like the LAB within the school day to promote female interest in STEM. Increasing the number of female students who have access to nontraditional STEM coursework could increase interest in STEM and beliefs about STEM, thus increasing the number of female students who report a desire to matriculate into collegiate STEM majors.

Theme Two: *Influential relationships altering perception and science attitudes* is centered around positive interactions with female mentor teachers, other lab aides, and the LAB community, as well as changes in science attitudes and perceptions of females in STEM. Female interest and matriculation in STEM is a complex, multi-faceted topic, but there is a link between inspiration and STEM persistence in females (Dasgupta & Stout, 2014; Stearns et al., 2016; Stout et al., 2011). Female students need to be supported by female role models and mentors in STEM to feel efficacious as one's own ability to succeed at specific tasks is influenced by social persuasion and vicarious experiences via live modeling and symbolic modeling (Bandura, 1986). Previous research suggests female teachers have "powerful effect" on the probability of female students matriculating into STEM degree programs (Bottia et al., 2015). All the LAB participants spoke of respect for their female mentor teachers, often referring to them as relatable, real, and caring. Participants spoke of the close relationship they shared with their mentor teachers and how the relationship positively impacted their lives. Participants felt they had an ally in their mentor teacher who gave them advice beyond STEM and was there for them both personally and professionally. Mentor teachers play an enormous role in encouraging the next generation of female scientists (NGCP, 2016) and are instrumental in making STEM relatable, approachable, relevant, and enjoyable (Dasgupta & Stout, 2014; NGCP, 2016; NRC, 2011; NSB, 2015).

Personal relationships formed by being a part of the LAB were indicated as significant contributors to interests and beliefs about STEM because female lab aides had opportunities to work together in STEM. Subsequently, innovative STEM programs are pairing students in mentor/mentee type relationships as they are mutually beneficial for everyone involved (Cutright & Evans, 2016). Participants described the impact of interactions with other lab aides and the LAB community, appreciating being a part of something they saw as significant. Learning communities are trending in because they offer opportunities for intellectual growth and involvement with like-minded people (Graham et al., 2013). Considering that it is well documented that females need to see other females who find STEM pleasurable and significant (Dasgupta & Stout, 2014), it should be noted that participants appreciated the sense of collegiality formed with other female lab aides and commented on the friendships formed as a result of their shared interests and time together. Participants felt the LAB had its own society where is was cool to be a smart girl interested in STEM and no one felt like an outsider. Participation in the program provided a safe haven where participants always had someone with whom they identified and with whom they could talk.

Confidence is a significant contributor in female students' decision to matriculate in STEM or to drop out (Huang, 2003). Studies of male and female students in STEM disciplines have revealed gender differences in academic self-confidence which favor males even though actual differences in ability are less often observed on measures of academic performance (Nosek, Banaji, & Greenwald, 2002b; Phillips, 2017; Reuben, Sapienza, & Zingales, 2014; Thoman & Sansone, 2016). Considering the marked disparity in STEM confidence and performance in students as they relate to gender, changes in science attitudes were discussed across all participants who communicated an increase in self-confidence and an "I can do this" attitude towards science after participation in the LAB. The positive relationship between participation in the LAB and improved science attitudes suggests a need for more programs geared towards supporting female interest and persistence in STEM. Prior to high school and participation in the LAB, participants reported varying degrees of interest in STEM from little to no interest in STEM. However, after matriculating in the LAB, all participants reported majoring in a STEM degree program in college.

Participants credited the LAB with increasing their opportunities and scientific skills, but also altering their perceptions of females in STEM. Reports of standing out because of gender and having to get used to being the only female in a male dominated room are not uncommon in STEM classrooms in college (Anft, 2017). Being a girl and being a lab aide were seen harmoniously as opposed to mutually exclusive concepts. When culture associates males with science and females with the arts, subconsciously female students do the same (AWS, 2016). This was not the case with the LAB participants who no longer envision men when asked to describe scientists, but instead see themselves and each other as scientists. Female representation in STEM careers and classrooms matter as female students need to see female teachers with whom they can identify as scientists (Thomas, 2017). Participation in the LAB gave participants access to other females in STEM. This access provided participants the opportunity to gain a holistic idea of females as scientists. This comprehensive view included what the female mentor teachers did as well as how they thought and behaved, which ultimately allowed them to serve as inspirational role models to the female student participants in the LAB. and showed them what females in STEM really look like. The personal relationships they formed through the LAB went beyond the classroom and impacted how they saw themselves and other females in STEM.

Significance of the Findings

The United States is in a STEM race it is losing to other nations around the world. The latest ranking of top countries in math, reading, and science based on the PISA have been released and the United States did not rank in the top 10 for any subject area. The United States ranked 25th in science behind other developed and developing nations (Jackson & Kiersz, 2016). This is a particular concern with regards to the United States' global standing and the global market as STEM jobs in the United States are projected to grow. Conservative estimates indicate U.S. companies will need 1.6 million new employees with STEM skills over the next five years (Tanenbaum, 2016). Despite the growth of STEM related jobs, there is a shortage of skilled workers to fill the growing demands of industry (Evans, McKenna, & Schulte, 2013). Although there is a demand for STEM skilled individuals, female students do not report substantial interest in STEM careers. By the age of 18, only 19% of female high school students report an interest in

STEM coursework compared to 33% of male high school students (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2017). In an effort to increase interest and access to STEM coursework, the *Every Student Succeeds Act of 2015* charges educators with increasing access to meaningful STEM programs and increasing the number of females involved in STEM in order to improve cultural diversity in the STEM workforce (SCHELP, 2015). However, in order to increase the feasibility of this task educators must explore nontraditional STEM programs that employ active learning experiences and mentoring relationships, variables known to increase the matriculation of females in STEM. Even with a wealth of research to substantiate a STEM curriculum overhaul, the U.S. educational system still trends towards the traditional school model which has been known to encourage a leaky STEM pipeline (Burke & McNeill, 2011; Samarasinghe, 2017). If we are to regain global status as a STEM powerhouse, it is imperative that we offer STEM programs outside the traditional classroom setting (Dasgupta & Stout, 2014). Data from this study show the LAB is a viable nontraditional pre-collegiate STEM opportunity that promotes the mentoring relationships and science exposure known to positively impact beliefs and interests in STEM which influence choices to matriculate into collegiate STEM degree programs and persist in STEM careers.

STEM education is critical to the lives of all Americans as it guarantees students develop an in-depth understanding of not only content but also skills such as communication, collaboration, inquiry, problem solving, and flexibility (NGSS, 2017). In order to increase female matriculation in STEM majors and careers, female students of STEM must be considered in any pre-collegiate STEM opportunity as they have a significant influence over one another with regard to science attitudes, indicating a need to foster STEM community as a component of STEM programs. The findings from this study indicate female mentor teachers and role models, as well as female peers, support positive science attitudes, development of STEM identity, and build confidence with regards to science ability in female students of STEM.

The implementation of nontraditional STEM programs to supplement the core curriculum provides greater access to STEM coursework for all students; however, educators must offer programs that target variables known to impact female interests and beliefs in STEM that are accessible to everyone, everywhere. A crucial component in the retention of females in STEM is access to pre-collegiate STEM opportunities which offer extended opportunities for practice and skills acquisition, as well as real world application of the material within the school day. The LAB program offers these variables at no cost to the participant or the school system. The program is relatively easy to implement within a traditional school schedule with administrative support allowing for a greater number of students to take advantage of participation in the program.

Implications of the Findings for Practice

This study presented a picture of female students who participated in the LAB at a large, suburban high school. Their stories provided insight regarding the impact of participation in the LAB on their interests and beliefs in STEM. It is from their stories that I explored the phenomenon. The emergence of core themes serves as the basis for my implications and recommendations. Study findings indicate access to pre-collegiate STEM programs, which offer opportunities for active learning and provide female role models, have a powerful effect on female students' science attitudes and self-efficacy. As such, these factors relate to an increased rate of matriculation into collegiate STEM degree programs and the subsequent pursuit of careers in STEM fields. The implications of this phenomenological study extend to practices at FHS, other schools, as well as to district, state, and national practices. Additionally, the findings of this study may be used by other educators to implement a similar pre-collegiate STEM program at their respective educational institutions.

At FHS the implications of this study will be felt by current and future students who may benefit from changes suggested by participants as well as other insights illuminated by the study gained by myself as the program coordinator. Additionally, these findings may enable the program to grow as administrative support increases and more students of diverse demographics are able to participate. Implications for FHS include exploring the possibility of assigning multiple lab aides to work under one mentor providing a greater opportunity for lab aides to learn from one another and foster a community of learners. By involving more mentor teachers, the LAB will expand and diversify to serve a wider range of students, including underserved students, cultural minorities, and students with disabilities.

In general, study participants found involvement in the LAB both enjoyable and useful, thus positively impacting their beliefs and interests in STEM. The implications of this study could be extended to other schools interested in implementing the LAB by considering the following recommendations:

- To reach a wider population of students with varying science skills and abilities, scaffolding structures should be implemented with a dedicated curriculum for first, second, and subsequent semester lab aides, supporting STEM skills acquisition.

- Technical writing should be implemented often with choice in research topics.
- Communication skills should be emphasized by offering opportunities for collaboration.
- Fostering a strong science community within the program should be a priority as female and minority students are impacted by role models and peers with whom they can identify.
- A goal of rotating lab aides through multiple science labs focused on different disciplines should be established, providing a richer overall experience.
- A survey of invested teachers and potential lab aides should be utilized to ensure like-minded participants and mentors are paired, thus increasing the likelihood of a positive STEM experience.

On the basis of the research conducted during this study, the aforementioned recommendations provide a starting point for the establishment of a LAB at other schools.

While the LAB at FHS is an isolated phenomenon, the nature of this study allows for its findings to be used by other educators who are interested in providing alternative STEM programs within the school day. Those interested in implementing the LAB at their school could use the background information offered in Chapter 3 for an overview of the program and the findings of the study in this chapter to substantiate the overall potential benefits. The LAB can provide a pre-collegiate STEM course framework which allows for flexibility in course scheduling within the school day. Additionally, assignments and responsibilities can be personalized to the ability level and needs of diverse learners and responsibilities can be differentiated as needed.

Implementation of a standard set of formal assignments for first, second, and subsequent semesters can be added to scaffold learning and solidify areas of need making the LAB framework adaptable to multiple abilities, ages, and grade levels. Suggested assignments in addition to lab work could include analyzing existing scientific studies for credibility, data analysis using real data sets, as well as reviewing and critiquing scientific literature. The longer students are involved in the LAB, the more opportunities they will have to engage in science activities. Finally, the open structure of the program allows anyone who in interested in offering a non-traditional pre-collegiate STEM opportunity enough latitude to modify scheduling, participation, and curriculum as needed.

Other schools and teachers may find it beneficial to implement a LAB at their school; however, the main hurdles to implementing a LAB in a secondary school are student course scheduling, teacher mindset, and administrative support. There are curricular structures in place in the Georgia State Science Standards that support a school's entry into the LAB. There are courses in place that can be utilized for student scheduling within the school day. The Science Research courses offer flexibility in scheduling and flexibility in student achievement. Additionally, schools could utilize the Honor's Mentorship Program and Gifted Internship course numbers for the same flexibility in scheduling and course achievement goals. Another step in the implementation process is the encouragement of positive teacher mindset towards the LAB. Teachers will need support and mentoring as they learn how to effectively mentor the LAB participants. This can be accomplished by offering professional development on the role of mentorship in student lives and the positive impact it has on science attitudes and STEM self-efficacy, especially concerning gender and cultural minority students.

The third hurdle of implementing a LAB would involve convincing the school administration the program is a valuable opportunity for both the students and the school community to satisfy the demands of recent STEM education policies. Some of the typical concerns from an administrative perspective are leadership of the LAB program, community acceptance, and funding. These hurdles can be mitigated by educating administrators on the positive impact of pre-collegiate STEM opportunities on student STEM choice. Leadership of the LAB can involve one or many teachers. A LAB program coordinator could handle scheduling and grading, while mentor teachers could volunteer to work with lab aides. The number of willing mentor teachers will determine the size of the program with regards to involvement. Additionally, my study findings indicate the LAB has a positive influence on participants with regard to the creation of a science community within the school. Lastly, as the program is offered during the school day, it can be implemented utilizing existing resources and funds already in place. The program does not necessarily require any additional funding because program participants are working within the framework of existing traditional courses. While challenges exist, the benefits of the LAB far outweigh the challenges as pre-collegiate STEM access is directly linked to female interests and beliefs about STEM.

There are educational platforms currently in place that encourage inclusiveness of female and cultural minorities in STEM offering a platform for dialog about course offerings in public schools. *Every Student Succeeds Act of 2015* (ESSA) charges educators with expanding STEM course offerings and increasing access to STEM to underserved and cultural minority students (SCHELP, 2015). Educators can use these policy structures to open dialog about the implementation of nontraditional pre-collegiate STEM courses that supplement traditional science courses such as Biology, Chemistry, and Physics. Non-traditional STEM coursework could gain a foothold as more schools adopt a policy of additional access and exposure to STEM per ESSA. This may encourage districts and states to explore alternative system programming for which the LAB is a viable option.

Recommendations for Future Research

This study contributes to the existing literature on pre-collegiate STEM opportunities and their impact on female students' beliefs and interest in STEM. While this study used a phenomenological approach to explore the lived experiences of female lab aides, a mixed methodology approach to research utilizing survey and focus group data may provide a broader student perspective and contribute more data to the existing literature. The aforementioned methodology could provide additional data on perceived strengths and weaknesses of the program, as well as eliciting more data about what female lab aides would suggest to improve the LAB and, perhaps, to increase the number of female students interested in collegiate STEM majors. It would also be valuable to expand this study to the greater population of lab aides as this study focused only on perceptions of female lab aides regarding the impact of participation in the LAB on their beliefs and interest in STEM.

Another recommendation for future research would be to extend this study to other demographics of students including cultural minorities and male students. Since the goal of this study was to identify the impact of participation in the LAB on females, there were no gender or cultural minority comparisons made between lab aides nor was a control group used in the research design. It would be pertinent to determine what components of the LAB impacted beliefs and interests in STEM in other demographics of students, if any. It would also be helpful to compare what male and female participants report as the most beneficial and least useful components of the LAB. Since gender disparity in STEM education is a much researched topic, data from a study of this kind could provide further information as to what motivates STEM interest thus providing a wider range of implications.

Continued data collection could provide insight into the long term impacts of participation in the LAB. A longitudinal study following participants from the LAB through college academic paths could provide further data on sustained interest in STEM, as well as information on the matriculation of female students who participated in the LAB from collegiate STEM degree programs into STEM careers. Interviewing LAB participants post college graduation could provide insight into current STEM goals to determine and to what degree, if any they credit the LAB with their current status. I would be curious to know which components of the LAB they recall as most impactful approximately 4-10 years after participation.

A longitudinal study following participants from the LAB through college academic paths could provide further data on sustained interest in STEM and the matriculation of female students in collegiate STEM degree programs into STEM careers. Interviewing LAB participants after college graduation could provide information concerning their STEM goals after matriculation in a collegiate STEM program and to determine to what degree, if any, they credit their participation in the LAB with their current STEM status. I would be curious to discover which components of the LAB participants recall as most impactful approximately 4-10 years post participation in the LAB.

Additional Considerations

The study occurred on one subset of student lab assistants who attended FHS. Given the number of female students in the study, the data may not be generalizable to all students in the program or to all students who may participate in lab aide programs like this one at other high schools. Several students who were interested in participating in the study did not satisfy the study parameters and therefore were not selected as participants. Specifically, one participant was not selected because she was not yet 18 years of age. Others who expressed interest in participating in the study were disqualified because they had one or more parents involved in a STEM career. Additionally, students who agreed to participate in this study were known to me. This familiarity may also have limited the study as a selection bias, as these students might have had a uniquely positive experience with the LAB and thus data might err to reflect positive experiences and not extensively speak to weaknesses or negative aspects of the LAB; however, Quinney, Dywer, and Chapman (2016) suggest the rapport I established before conducting this study increased the quality of the data I attained mitigating selection bias. Lastly, students who participated in the study chose to be a part of the LAB, therefore their experiences with STEM and the LAB might not be considered “average” or “typical.” Though I feel study findings would replicate in similar groups of female students, there is no guarantee the experiences of these five LAB participants are representative of the whole. It is possible that the findings of the study may not be transferrable to a larger population.

An additional consideration concerns phenomenological methodology as a research tool. If participants are not known to the researcher, data may be negatively impacted as rapport with participants must be established prior to data collection in order to elicit rich data (Quinney, Dywer, & Chapman, 2016). This variable adds an additional layer of consideration as it will require additional time and resources and add to the research timeline. If potential research participants are not known to the researcher, phenomenological methodology may not be the best approach to study the impact of pre-collegiate STEM opportunities on interests and beliefs in STEM. A particular challenge for me regarding phenomenological methodology dealt with interview protocols with regards to scheduling interviews. My study involved first semester college students who have busy schedules. Per Seidman (2006), participant interviews must occur 3-7 days apart. Scheduling interviews within this timeframe provided challenges with my full-time job as my availability and that of the participants did not always align. Additionally, this methodology required time and resources as extensive travel was required in order to conduct all 15 interviews within the timeline provided by Seidman (2006). In order to comply with interview protocols, I had to take personal time from work which might not be a possibility for all researchers. Recommendations for dealing with these issues include conducting research during the summer when study participants are more likely to have flexibility in their schedules or extending the research timeline allowing time for building rapport and to follow interview protocol.

Conclusions

The LAB offers participants opportunities for prolonged exposure with science content as well as the real world application known to increase female interest in STEM.

Because the LAB is offered within the school day, it is accessible to a greater number of students because transportation and financing are not an issue. Additionally, the LAB schedule provides for extended face time beyond what after-school programs, clubs, and summer camps offer.

The participants are given a choice in research and taught to work in a lab setting. Lab work occurs independently and in groups settings fostering collegiality and teamwork. The LAB promotes critical thinking, problem solving, research, and technical writing. Opportunities for extended practice allow for greater confidence in STEM abilities. Per the former lab aides interviewed for this study, skills acquired via the LAB are transferable to other science courses and content areas.

Participants forge relationships with other lab aides and their mentor teachers who often act as role models making STEM careers seem attainable and desirable. Being a part of the LAB community provides a sense of belonging and nurtures social norms of females in STEM. Through the LAB, female participants see other lab aides and mentor teachers who feel efficacious in STEM increasing their reports of self-confidence and decreasing reports of self-doubt. No longer do participants report science as male and art as female but recognize anyone can be anything given the opportunity.

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APPENDIX A:

Interview Protocol Adapted from Seidman

Interview Protocol adapted from Seidman (2006, pp. 15-19)

Interview 1 – Focused Life History

Reconstruction of early experiences. Please describe your earliest experiences with science from your earliest memories to the present time.

Possible Questions: Previous Experiences

1. Describe your earliest memory that involves STEM (P*)
2. Describe your earliest memory of a scientist. (If need prompting, perception of a scientist.) (P)
3. Describe your earliest memory of being educated about science at school. (P, E*)
4. Describe an experience from your childhood that made an impact on your science education. (If applicable.) (P, E)
5. Describe your STEM education in elementary school. (E)
6. Describe your STEM education in middle school. (E)
7. How did you become a participant in the LAB program? (If need prompting, describe the events that led you to become a participant in the LAB program.) (E)
8. What memories do you have of being exposed to science as a young child? (P)
9. What was your first experience of science in school like? (E)
10. When did you first conduct a scientific experiment (prior to school, in school, what grade, etc.)? Please describe it. (P, E)
11. Whom do you credit with teaching you about scientific experimentation/research (i.e. parent, teacher, self, etc.)? (P)
12. How much do you remember conducting scientific experimentation/research at home, in elementary school, at middle school, in high school? In what ways do you think science has been valued in your classes? What about amongst your friends? (P, E)
13. Can you describe the emphasis placed on science at home? What types of materials were available there? (E)
14. For what purposes have you seen your parents conduct scientific research/experimentation (pleasure, work, information gatherings, other)? (E)
15. How do you feel about your ability to conduct scientific experimentation/research? (P)

Interview 2 – Details of the Experience

Present lived experience. Please reconstruct the details of your experience as a participant in LAB.

Possible Questions: LAB Experience

1. Talk about your experience in the LAB program. (P, E, B*)
2. Describe your daily activities as a LAB assistant. (B)
3. Describe your relationship/interactions with your mentor teacher. (B)
4. Describe your relationship/interactions with other lab assistants. (B)
5. Describe your interaction with the community as a lab assistant. (B)
6. Describe your duties as a lab assistant. (B)
7. Describe your assignments as a lab assistant. (B)
8. Can you share any stories or anecdotes pertaining to your experience in the lab aid program? (P)

Interview 3 – Reflection on the Meaning

Intellectual and emotional connections between work and life. Please reflect on your experiences as a participant in LAB and your connection to science.

Possible Questions: Personal LAB Connection

1. Given the way you described your life before you became a lab assistant, describe what the LAB program means in your life. (P)
2. Describe the impact that your participation in the LAB program has had (if any) on your life. (P)
3. Describe a scientist. (P, B)
4. What do you think the role of females in science is/should be? (P)
5. Has the LAB program influenced your perception of women in science? If so, how? (P)
6. Do you consider yourself a scientist? If so, describe what this means to you within the context of the LAB program? (P, B)
7. Do you feel the LAB program has allowed you to pursue certain areas of science that you are more interested in? If so, explain how. (P, B)
8. What has your participation in the lab aid program contributed to your education (if anything)? (P)
9. How have the teachers involved in LAB impacted your education (if at all)? (P, E, B)
10. How has your participation in the LAB program influenced your goals (if at all)? (P, B)
11. What elements of the LAB program could be improved or changed? (P)
12. In what ways do you think science/being able to conduct scientific inquiry is an important skill to have? (P)
13. Please describe any difficulties in science you have experienced. (P)
14. How have your abilities in science and your feelings about science influenced your collegiate major? (P, B)
15. At what point in your education did you start thinking about pursuing this major? (P, B)
16. Can you name your specific reasons for deciding to choose this major? In what ways was your experience in the LAB program involved? (P, E, B)
17. Please describe your non-academic scientific interest before the LAB research program and at present time. (P, E, B)
18. What areas of science interest you the most? How do you gain experiences in this/these areas? How did you decide these areas are the most interesting to you? (P, E, B)

* Using Bandura’s Terminology (Bandura, 1997), P indicates personal factors, E indicates environmental events, and B indicates behavioral patterns.

APPENDIX B:

Recruitment Flyer

Recruitment Flyer

Are you a female student who participated in a student lab assistant research program?

If you have participated as a student in a lab assistant research program and are interested in participating in a research study, please complete the attached qualifying questionnaire and contact Brittney Cantrell.

Contact information:
Brittney Cantrell
bdcantrell@valdosta.edu
Thank you!

Questions regarding the purpose or procedures of the research should be directed to Brittney Cantrell at bdcantrell@valdosta.edu. This study has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-259-5045 or irb@valdosta.edu.

APPENDIX C:

Qualifying Questionnaire

Qualifying Questionnaire

Sponsored Programs and Research Administration
1500 N. Patterson St.
Valdosta, GA 31698

Valdosta State University, Doctor of Education Program, School of Education

Principal Researcher: Brittney Cantrell

Research Title: A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants

Qualifying Questionnaire

Thank you in advance for completing this questionnaire. Your time and efforts are greatly appreciated. Your responses will be used to determine if you meet the study requirements as well as providing demographic data about you should you choose/be chosen to participate in this study. You can skip any question that you prefer not to answer. Please note that your responses are confidential.

Name: ____

Please supply the answer that most accurately represents you.

Number of consecutive semesters you have been involved in a student lab assistant research program: ☐ 1 ☐ 2 ☐ 3+	Age: ☐ 12-17 ☐ 18-24 ☐ 25-34
Gender: ☐ Male ☐ Female ☐ Prefer not to answer	Last grade level completed: ☐ 9 ☐ 10 ☐ 11 ☐ 12 High school graduation date:
Are you enrolled in a college or university during fall semester of 2017? ☐ Yes ☐ No	Have you reported an intention to major in a collegiate STEM degree program? ☐ Yes ☐ No
Are either of your parents involved in a STEM career field? ☐ Yes ☐ No	Racial/ethnic identification: ☐ ______________________ ☐ Prefer not to answer

Questions regarding the purpose or procedures of the research should be directed to Brittney Cantrell at bdcantrell@valdosta.edu. This study has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-259-5045 or irb@valdosta.edu.

APPENDIX D:

Email to Potential Participants

Email to Potential Participants

From: Brittney D Cantrell
Sent: Wednesday, October 11, 2017 11:26 AM
To: [redacted]
Subject: Request for Participation in A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants

Greetings,

I hope you are well. I am reaching out to you today in hopes of securing your participation in a study I am conducting for my doctoral program. The objective of this study is to explore the lived experience of female students who participate in a Student Lab Assistant Research Program (LAB) in order to understand the impact of this pre-collegiate STEM opportunity on female students' interest and beliefs about STEM.

This is a worthwhile study because the number of people seeking degree programs in STEM and entering STEM fields is not high enough to fill the demand for STEM qualified individuals in the workplace. Women could help close this gap but are highly underrepresented in STEM. Proportionally more females than males left STEM degree programs in college by switching to a non-STEM major (32 percent vs. 26 percent) suggesting that high schools do not adequately prepare females for collegiate STEM. Traditional science coursework often lacks characteristics shown to impact the matriculation of women in STEM such as extended engagement, mentorship, and active learning experiences. This lack of appropriate science curriculum at the high school level does not adequately prepare women for the rigors of STEM courses at the collegiate level. Exploration of the LAB program through the lens of recently former female participants could provide unique insight into the shared lived experiences of young people and allow for the exploration of LAB as a potential pre-collegiate research opportunity that offers continued engaging, individualized, and real-world content.

If you choose to participate in this study, you will be asked to participate in a series of interviews about your experiences with LAB. The interviews will be audio taped in order to accurately capture your concerns, opinions, and ideas. Once the recordings have been transcribed, the tapes will be destroyed. This research study is confidential. No one, including the researcher, will be able to associate your responses with your identity. Your participation is voluntary. You may choose not to participate, to stop responding at any time, or to skip questions that you do not want to answer. You must be at least 18 years of age to participate in this study. Your participation serves as your voluntary agreement to participate in this research project and your certification that you are 18 or older.

Questions regarding the purpose or procedures of the research should be directed to Brittney Cantrell at bdcantrell@valdosta.edu. This study has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-259-5045 or irb@valdosta.edu.

Attached you will find a recruitment flyer with basic information about the study, a Research Consent document detailing the study, and a Qualifying Questionnaire. Should you choose to participate in the study, please complete the Qualifying Questionnaire and contact me so that we may schedule your interview(s).

Fondly,
Brittney Denier Cantrell
Doctoral Candidate
Valdosta State University

APPENDIX E:

Research Consent Document

Research Consent Document

Sponsored Programs and Research Administration
1500 N. Patterson St.
Valdosta, GA 31698

Valdosta State University, Doctor of Education Program, School of Education

Principal Researcher: Brittney Cantrell

Research Title: A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants

Research Statement: You are being asked to participate in an interview as part of a research study entitled "A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants," which is being conducted by Brittney Cantrell, a graduate student at Valdosta State University. The purpose of this study is to explore the lived experience of female students who participate in a Student Lab Assistant Research Program (LAB) in order to understand the impact of this pre-collegiate STEM opportunity on female students' interest and beliefs about STEM. The interviews will be audio taped in order to accurately capture your concerns, opinions, and ideas. Once the recordings have been transcribed, the tapes will be destroyed. This research study is confidential. No one, including the researcher, will be able to associate your responses with your identity. Your participation is voluntary. You may choose not to participate, to stop responding at any time, or to skip questions that you do not want to answer. You must be at least 18 years of age to participate in this study. Your participation serves as your voluntary agreement to participate in this research project and your certification that you are 18 or older.

Questions regarding the purpose or procedures of the research should be directed to Brittney Cantrell at bdcantrell@valdosta.edu. This study has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-259-5045 or irb@valdosta.edu.

APPENDIX F:

Confidentiality Agreement for Transcriptionist

Confidentiality Agreement for Transcriptionist

Sponsored Programs and Research Administration
1500 N. Patterson St.
Valdosta, GA 31698

Valdosta State University, Doctor of Education Program, School of Education

Principal Researcher: Brittney Cantrell

Research Title: A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants

Confidentiality Agreement – Transcriptionist

I, ___________________________________, hereby agree that I will maintain complete confidentiality of all audio recorded interviews that I have been contracted to transcribe for a doctoral research study: **A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants**. Complete confidentiality means that I will faithfully transcribe the audio recordings and I will not share or discuss any of the audio recorded or transcribed data with anyone other than the principal researcher, Brittney Cantrell. At the culmination of the transcriptions, I will delete all audio recordings and transfer all electronic files to the principal researcher. Upon confirmation of receipt, I will destroy all files associated with this study.

A copy of this document will be provided for your records.

Printed name of the person above: ____

Signature of the individual who will be transcribing data for the study:

____ Date: ________________________

Signature of Researcher Brittney Cantrell:

____ Date: ________________________

APPENDIX G:

Analysis of Phenomenological Data

Moustakas' Modification of the Stevick-Colaizzi-Keen Method of
Analysis of Phenomenological Data

1. Using a phenomenological approach, obtain a full description of your own experience of the phenomenon.

2. From the verbatim transcript of your experience complete the following steps:

   a. Consider each statement with respect to significance for description of the experience.
   b. Record all relevant statements.
   c. List each nonrepetitive, nonoverlapping statement. These are the invariant horizons or meaning units of the experience.
   d. Relate and cluster the invariant meaning units into themes.
   e. Synthesize the invariant meaning units and themes into a description of the textures of the experience. Include verbatim examples.
   f. Reflect on your own textural description. Through imaginative variation, construct a
   description of the structures of your experience.
   g. Construct a textural-structural description of the meanings and essences of your experience.

3. From the verbatim transcript of the experiences of each of the other co-researchers, complete the above steps, a through g.

4. From the individual textural-structural descriptions of all co-researchers' experiences, construct a composite textural-structural description of the meanings and essences of the experience, integrating all individual textural-structural descriptions into a universal description of the experience representing the group as a whole (Moustakas, 1994, p. 122).

APPENDIX H:

Protecting Human Research Participants

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Brittney Cantrell (ID: 1836438)
- **Institution Affiliation:** Valdosta State University (ID: 475)
- **Institution Email:** bdcantrell@valdosta.edu
- **Institution Unit:** Department of Curriculum, Leadership and Technology
- **Phone:** (706) 344-7592

- **Curriculum Group:** Human Research
- **Course Learner Group:** IRB Basic
- **Stage:** Stage 1 - Basic Course
- **Description:** This course is suitable for Investigators and staff conducting SOCIAL / HUMANISTIC / BEHAVIORAL RESEARCH with human subjects. The VA module must be completed if you plan to work with subjects at a VA facillity.

- **Record ID:** 22021174
- **Completion Date:** 27-Aug-2017
- **Expiration Date:** 26-Aug-2020
- **Minimum Passing:** 80
- **Reported Score*:** 100

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
History and Ethical Principles - SBE (ID: 490)	27-Aug-2017	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	27-Aug-2017	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	27-Aug-2017	5/5 (100%)
Basic Institutional Review Board (IRB) Regulations and Review Process (ID: 2)	27-Aug-2017	5/5 (100%)
Assessing Risk - SBE (ID: 503)	27-Aug-2017	5/5 (100%)
Informed Consent - SBE (ID: 504)	27-Aug-2017	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	27-Aug-2017	5/5 (100%)
Valdosta State University (ID: 746)	27-Aug-2017	No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?kaed32a52-5dbb-45c0-84e8-4292bcfba84e-22021174

Collaborative Institutional Training Initiative (CITI Program)
Email: support@citiprogram.org
Phone: 888-529-5929
Web: https://www.citiprogram.org

APPENDIX I:

IRB Approval

IRB Approval

Institutional Review Board (IRB)
For the Protection of Human Research Participants
PROTOCOL EXEMPTION REPORT

PROTOCOL NUMBER:	03531-2017	**INVESTIGATOR:**	Ms. Brittney Cantrell
		SUPERVISING FACULTY:	Dr. Regina Suriel
PROJECT TITLE:	***A LAB of Her Own: A Phenomenological Study of a Student Lab Assistant Research Program and Its Impact on Female High School Participants.***		

INSTITUTIONAL REVIEW BOARD DETERMINATION:

This research protocol is **Exempt** from Institutional Review Board (IRB) oversight under Exemption **Category 2.** You may begin your study immediately **(10.02.2017).** If the nature of the research project changes such that exemption criteria may no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research.

ADDITIONAL COMMENTS:

- *It is required that when requesting data* [redacted] *that the requested data that has been stripped of personal identifiers (social security numbers, date of birth, etc.).*
- *The Research Statement must be read aloud to each participant at the start of audio taping. The researcher's voice must be part of the taped interview, and included in the transcripts as documentation/proof that the participant was informed.*
- *Upon completion of your research study, compiled data (including – email addresses, data lists, etc.) must be securely maintained (locked file cabinet, password protected computer, etc.) for a minimum of 3 years.*

☒ ***If this box is checked, please submit any documents you revise to the IRB Administrator at irb@valdosta.edu to ensure an updated record of your exemption.***

Elizabeth W. Olphie 10/02/2017
Elizabeth W. Olphie, IRB Administrator Date

Thank you for submitting an IRB application.
Please direct questions to irb@valdosta.edu or 229-259-5045.

Revised: 06.02.16